5th Annual CMMI Technology Conference and User Group

Denver, CO

14-17 November 2005

Agenda

Monday, 14 November 2005

Tutorial Tracks

Track 1:

- Calculating CMMI-Based Return on Investment (ROI): Why, When, What, How?, Mr. Rolf W. Reitzig, Cognece, Inc.
- A Practical Guide to Implementing Levels 4 and 5, Mr. Rick Hefner, Northrop Grumman Corporation

Track 2:

- Agile/Lean Workshop, Mr. Jeffrey Dutton, Jacobs Sverdrup
- Mr. Tim Kasse, Kasse Initiatives, LLC:
    1. Leveraging ITIL Services (Suppport and Delivery) Capability and Maturity with the CMMI
    2. Service Management "A Process Led Approach"
    3. ITIL IT Infrastructure Library Overview
    4. Overview of Service Support & Service Delivery Functions
    5. Configuration Management & Change Management
    6. "Service Support" Change Management
    7. "Service Support" Configuration Management
    8. Configuration Management & Change Management ITIL - CMMI
    9. ITIL Process Maturity Self-Assessment & Action Plan

Track 3:

- The Look and Feel of a Successful CMMI Implementaiton, Mr. Tim Kasse, Kasse Initiatives, LLC
- How to Define CMMI Based Process That are Short and Usable and Using a Process Measurement Framework to Successfully Achieve Measurable Results, Mr. Timothy G. Olson, Quality Improvement Consultatnts, Inc.

Track 4:

- Using Simulation to Support Better Management Decisions, Dr. David M. Raffo, Portland State University
- Institutionalizing Resource Planning and Management Part I and Part II, Mr. Donald A. Borcherding, NexSummit, LLC

Track 5:

- The CMMI V1.2 ... A Tutorial, Mr. David M. Phillips, SEI

Track 6:

- Integrated Porject Management (IPM) - The CMMI and Collaborative Product Develop and Requirement Engineering: A Practicial Approach to Modeling and Managing Requirements, Mr. William J. Deibler, II Software Systems Quality Consulting - SSQC

Tuesday, 15 November 2005

General Sessions

LTG Joseph Yakovac, USA, Miliatry Deputy Office of the Secretary of the Army, Acquisition, Logistics & Technology

Executive Panel: "How Has CMMI Improved Our Program & Project Performance -- Or Has It?":

Mr. Mark Schaeffer, Director, Systems Engineering, OUSD(AT&L) Defense System and OSD Sponsor, CMMI
- Mr. Dev Banerjee, Division Director, Systems & Flight Engineering, Boeing Integrated Defense Systems
- Mr. John Evers, Raytheon Processes Program Manager, Raytheon Common Engineering Process Program
- Brig Gen Gary Salisbury, USAF (Ret), Executive Director Business Development, Defense Mission Systems, Northrop Grumman Mission Systems

Lunch: CMMI State of the Model, Mr. Bob Rassa, Raytheon; Mr. Clyde Chittister, SEI

Technical Sessions

Track 1: CMMI Process Improvement

- CMMI/ISO - "Can't we all just get along?", Mr. Dale R. Spaulding, The Boeing Company
- Real World Application of IEEE Software Engineering Standards to CMM/CMMI Software Process Improvement Initiatives, Ms. Susan K. Land, Norhtrop Gurmman IT/TASC
- The CMMI Product Suite and International Standards -- An Update, Mr. David H. Kitson, SEI

Track 2: Practical Guidance

- Verification in CMMI using Peer Reviews - Presentation and Paper, Ms. Jeanne H. Balsam, Georgia Tech Research Institute
- Process QA in the Information Age: Keep it Light!, Hillel Glazer, Entinex, Inc
- Defect Datat and Configuation Management, Ms. Julie E. Schmarje, Raytheon Company

Track 3: Appraisals

- Wasted Days and Wasted Nights - Leveraging Your Appraisal Team as a Resource, Dr. Timothy J. Davis, Raytheon Missile Systems
- Building a Credible SCAMPI Appraisal Representative Sample, Mr. Robert L. Moore, III., Business Transformation Institute, Inc.
- Top 10 Signs You're Ready (or Not) for an Appraisal, Mr. Gary Natwick, Harris Corporation

Track 4: ROI & Benefits of CMMI

- Measuring Performance: Evidence About the Results of CMMI, Ms. Diane Gibson, SEI
- Prioritizing Process Improvement Strategies in CMMI to Optimize Business Objectives, Dr. Aldo Dagnino, ABB, Inc. US Corporate Research
- Implementing a Plan for Controlling ROI for CMMI Process Improvement, Mr. J. M. Perry, BAE Systems
- Lessons Learned in the Engineering of Process Performance Models on the Journey to Higher Maturity Levels, Mr. Dr. Mary Anne Herndon, SAIC

Track 5: Acquisition / High Maturity

- Getting Lost on the Way to Level 5, Ms. Kathy King, The Center for Systems Management
- Understanding Why?, Mr. David N. Card, Q-Labs

Track 6: Transitioning to CMMI

- Migrating Best Practices Within an Organization: Experiences in Adapting CMMI Policies and Procedures Used in One Part of a Business to Another, Mr. Scott Sherrill, Georgia Tech Research Institute
- An Enterprise Wide CMMI Implementation at Accenture, Ms. Sarah S. Bengzon, Accenture
- Stakeholder Identification and Involvement in the CMMI, Mr. James R. Armstrong, Systems and Software Consortium
- Ensuring the Right Process is Deployed Right: Synchronizing Process Checkpoints with Business Rhythm, Ms. Joan Weszka, Lockheed Martin Corporation

Track 7: CMMI for Small Projects anhd Organizations

- Making PPQA Work on Small Projects Presentation and Paper, Ms. Jean M. Swank, Georgia Tech Research Institute
- Does Size Matter in CMMI Implementation or Was Yoda Wrong?, Mr. Paul H. Meyers, SAIC

Wednesday, 16 November 2005

Technical Sessions

Track 1: CMMI Process Improvement

- A Change Agent in a Level 1 Organization; How to Survive in a Hostile Environment, Mr. Andrew Cordes, ABB - United States Corporate Research Center
- "Sound Systems Engineering Using CMMI, Mr. Michael T. Kutch, Jr., SPAWAR - Charleston
- Using CMMI to "Dig Out" from an Ad Hoc Development?, Mr. Donald A. Borcherding, NexSummit, LLC
- Strategic Planning: Selling a CMMI-Based Improvement Effort to Senior Management, Dr. Aldo Dagnino, ABB, Inc., US Corporate Research
- Enterprise Process Intergration within the Space and Airborne Systems Business Area of Raytheon, Mrs. Deana A. Seigler, Raytheon Company
- Interpreting the CMMI: It Depends!, Mr. Rick Hefner, Northrop Grumman Corporation
- CMMI as Safeguard Against Software Entropy: A Manager's Perspective, Dr. Thomas F. Christian, Jr., 402 SMXG
- "Its how big? How will you deploy it without killing my team and my program?", Mr. William Borkowski, Jr., Raytheon Missile Systems

Track 2: Practical Guidance

- Are You Making the Most of Your Project Schedules?, Ms. Susan Byrnes, PMP, Natural SPI, Inc.

- Keeping the Team Motivated for Success and “Barrier Busting” – Obtaining Active Leadership Support, Mr. Michael D. Scott, Raytheon Missile Systems
- Using a Level 3 Process to Achieve CMMI Level 3, Mr. Stephen Ross, Raytheon Company
- Accelerating Process Improvement through Collaboratio: The NAVAIR Systems Process Improvement Community of Practice, Ms. Katie Smith, Naval Air Systems Command
- What the CMMI Doesn't Say About Training (But Should!), Sree Yellayi, Siemens Corporate Research
- CMMI CP 2.8 Interpretation and Implementation: Is This Practice Just About Numbers?, Mr. Lester Stamnas, Norausky Process Solutions, Inc.
- Creating Helpful process Directives, Mr. Kenneth I. Weinberg, Raytheon Company

Track 3: Appraisals

- Lessions Learned in Helping Large and Small Organizations Prepare for their First Appraisal, Mr. Robert J. Pomietto, Center for Systems Management
- Behind Closed Doors, Mr. Tom G. Lienhard, Raytheon Missile Systems
- CMMI Appraisal Results: The Shocking Truth Revealed and Lead Appraisers Gone Wild, Ms. Margaret A. Glover, SEI
- Improving Document Reviews for Appraisals, Mr. Kent McClurg, Raytheon Company
- Finding CMMI Compliant Artifacts and a Needle in a Haystack, Adrio J. DeCicco, Raytheon Company
- Lessons Learned and Best Practices for Evidence Collection in Preparation for a SCAMPI Appraisal, Mr. Ben Berauer, Raytheon Company
- Maximizing Value for SCAMPI(SM) Preparation, Ms. Joan Weszka, Lockheed Martin Corporation

Track 4: ROI & Benefits of CMMI

- Evaluating the Impact New Tools and Technologies Using Simulation, Dr. David M. Raffo, Portland State University
- The ROI Dashbord (c): Understanding the Benefits of CMMI, Mr. Thomas L. McGibbon, ITT Industries, AES
- Quality Assurance Involvement Compared to Program Results, Ms. Jill Brooks, Raytheon Company
- Rapidly Achieving Measurable ROI Using Early Defect Detection, Mr. Timothy G. Olson, Quality Improvement Consultants, Inc
- CMMI Process Improvement: Its not a technical problem, its a people problem, Mr. Rolf W. Reitzig, Cognence, Inc.
- A Project's Perspective of a CMMI Level 5, Mr. Warren Scheinin, Northrop Grumman Corporation
- Achieving the Promised Benefits of CMMI, Dr. Rick Hefner, Norhtrop Grumman Corporation
- Measuring Economic Benefits of Process Improvement in CMMI Level 1 Organization, Dr. Aldo Dagnino, ABB, Inc., US Corporate Research

Track 5: High Maturity

- Logarithms Can Be Your Friends: Controlling Peer Review Cost?, Dr. Richard L. W. Welch, Northrop Grumman Corporation
- Journeys on the Road to Level 5, Mr. Joseph V. Vanderville, Northrop Grumman Corporation
- Lessons Learned on the SCAMPI Road to CMMI-Software Level 5, Mr. Joseph N. Frisina, BAE Systems
- Merging Measurement in Mature Companies - A Success Story of Measurement Process Integration, Ms. Sharon Rohde, Lockheed Martin IS&S
- The Road to Process Improvement Successes: CMMI Level 5/ISO 9001-2000 Business Model, Mrs. Debra S. Roy, BAE Systems, National Security Solutions
- Reducing Variation at Each CMMI Maturity Level?, Mr. Timothy Kasse, Kasse Initiatives, LLC
- Ways to Ensure the Culture Supports Level 5, Mr. Warren Scheinin, Northrop Grumman Corporation
- Analyzing Defects Can Tell a Story About a Company?, Ms. Diane A. Mitzukami-Williams, Northrop Grumman Corporation Mission Systems

Track 6: Transition to CMMI

- Combining Six IPTS and Transitioning to CMMI, Ms. Judy Overhouser-Duett, NAVAIR
- How to Transition Models and Disciplines - Looking for Transition in all the Wrong Places, Ms. Lori G. Smailes, TYBRIN Corporation
- Using SW-SMM SQA Independent Verificaiton as a First Step for the Transition to CMMI, Mr. Alfredo N. Tsukumo, CenPRA-Centro de Pesquisas Renato Archer
- Service Extensions to the CMMI, Mr. Craig R. Hollenbach, Northrop Grumman Corporation
- Applying CMMI to Services, Mr. Juan C. Ceva, Raytheon ITSS
- Management Challenges & Lessons Learned Implementing CMMI in a Services Environment, Mr. Thomas E. Zience, BAE Systems Information Technology
- CMMI v1.1 for a Service Oriented Organization, Mr. Steven K. Hall, Raytheon Corporation

Track 7: Measurement

- Software Size Growth and Uncertainity - Both Affect Estimate Quality and Project Risk Presentation and Paper, Mr. Michael A. Ross, Galorath, Inc.
- Building an Automated System to Support Measurement in CMMI, Dr. Richard Hayden, Pragma Systems Corporation
- Team of Three - How to Get Program, Functional and Process Management Working Together, Mr. Mark A. Marsh, Raytheon Company
- Parametric Project Monitoring and Control: Performance-Based Progress Assessment and Prediction Presentation and Paper, Mr. Michael A. Ross, Galorath, Inc.
- Measuring and Estimating Process Performance, Dr. Richard D. Stutzke, SAIC

Thursday, 17 November 2005

Technical Sessions

Track 1: CMMI Process Improvement

- “Barrier Busting” – Obtaining Active Leadership Support, Mr. Michael D. Scott, Raytheon
- Don’t Write the Wrong Processes!, Ms. Suzanne B. Zampella, The Center for Systems Management

- Contrasting CMMI Contrasting CMMI and the PMBOK, Mr. Wayne Sherer, Anteon Corporation
- Being Customer Oriented, Mr. Tim Kasse, Kasse Initiatives, LLC
- Learning from Lessons Observed - Mitigating Resistance to Process Improvement, Mr. Bob Norris, National Geospatial-Intelligence Agency

Track 2: Practical Guidance

- Supplier Management Strategy Considerations with CMMI, Mr. Rick Hefner, Northrop Grumman Corporation
- Simplifying Process Tailoring To Enhance Project Execution, Mr. Howard T. Kaplan, Raytheon Company
- CMMI and agile: a High Tech R&D Success Story, Mr. Gene Miluk, SEI
- How to Incorporate “Lessons Learned” for Sustained Process Improvements, Mr. Anil K. Midha, BAE Systems
- Data Management: The Hidden Enabler or (The Key Data and Work Product Integrator), Mr. Lester Stamnas, Norausky Process Solutions

Track 3: Appraisals

- Techniques for Shortening the Time and Cost of CMMI Appraisals, Mr. Sam Fogle, Systems and Software Consortium, Inc.
- Using Classified Programs in CMMI Appraisals, Mr. Kenneth I. Weinberg, Raytheon Company
- The Best Intentions of SCAMPI V1.1: What We Meant and What Some People Heard, Mr. Will Hayes, SEI
- A Quantitative Comparison of SCAMPI A, B, and C, Mr. Dan Luttrell, Northrop Grumman Mission Systems
- Performing Consistent Appraisals in a Global Organization, Ms. Jeanine Courtney-Clark, Integrated System Diagnostics, Inc

Track 4: ROI & Benefits of CMM I / SCAMPI B/C

- The Effects of CMMI on Program Performance, Mr. Joseph P. Elm, SEI
- Squeezing Variation for Profit, Mr. Donald R. Corpron, Northrop Grumman Corporation
- Process In Execution Review (PIER) and the SCAMPI B Method, Ms. Lorraine J. Adams, SEI
- Planning a SCAMPI C Appraisal from a Strategic Perspective, Mr. John P. Kennedy, The Mitre Corporation
- Critical Path SCAMPISM Getting Real Business Results from Appraisals, Mr. Michael J. West, Natural SPI, Inc.
- Using SCAMPI C for Collective Improvement Across a Multi-Business Program, Mr. Oktawian Nowak, Motorola, Inc.

Track 5: High Maturity

- A Statistical Approach to Product Quality Assurance, mr. Randall J. Varga, BAE Systems
- The Key to a High Maturity Rating is - ORGANIZATION, Mrs. Karen M. Pelletier, Northrop Grumman Corporation
- Paladin Drives Forward To CMMI® Maturity Level 5, Mr. Victor Elias, M.S., Armament Software Engineering Center, US Army
- Business Improvements Achieving CMMI®Level 5 at SAIC: Who Keeps Moving My Process?, Ms. Sharon Cobb Flanagan, SAIC
- Extending CMMI Level 4/5 Organization Metrics Beyond Software Development, Ms. Linda R. Brooks, Northrop Grumman Corporation

Track 6: CMMI Extensions

- Capability Maturity Model Integration (CMMI®) Tailoring for an IT/MS Services Environment, Ms. Stacy Savage, BAE Systems Information Technology
- Adapting CMMI for Acquisition Organizations: A Preliminary Report, Dr. Hubert Hofmann, General Motors
- How to Become Your Customer’s Software Provider of Choice, Mr. David Herron, DCG, Inc.
- Space and Missile Systems CenteSpace and Missile Systems Center, Mr. Keith Wright, SPARTA, Inc.
- Software Outsourcing with CMMI, Dr. John W. Mishler, SEI

Track 7: Systems Engineering

- Sound Systems Engineering using CMMI®, Ms. Sandee D. Guidry, TECHSOFT
- Systems Engineering Influence Throughout the CMMI, Mr. Tim Kasse, Kasse Initiatives, LLC
- Future of System and Software Engineering Project Management and the CMMI, Dr. Kenneth E. Nidiffer, Systems and Software Consortium

5th Annual

CMMI® Technology Conference and User Group

Conference Agenda

Sponsored by:

The National Defense Industrial Association

Systems Engineering Division

in conjunction with the

Software Engineering Institute,

Carnegie Mellon University

Carnegie Mellon
Software Engineering Institute

Event # 6110
November 14 - 17, 2005
Hyatt Regency Tech Center
Denver, CO

Sunday, November 13, 2005

12:00 PM - 4:00 PM
Registration for Conference and Tutorial — Atrium

Monday, November 14, 2005

7:00 AM - 5:00 PM — Atrium
Tutorial Registration ($200 Tutorial Fee)

7:00 AM - 8:00 AM — Atrium
Continental Breakfast (Tutorial Attendees Only)

8:00 AM - 5:00 PM — See Following Pages
CMMI Tutorial Tracks (Tutorial Attendees Only)

12:00 PM - 1:00 PM — Grand Mesa ABC
Lunch (Tutorial Attendees Only)

5:00 PM - 6:30 PM — Display Area
Reception **(All CMMI Conference Attendees)**

Tuesday, November 15, 2005

7:30 AM - 8:30 AM — Atrium
Registration and Continental Breakfast

8:30 AM - 8:45 AM — Grand Mesa DEF
Opening Remarks

8:45 AM - 9:30 AM — Grand Mesa DEF
Session A
LTG Joseph Yakovac, USA, Military Deputy, Office of the Secretary of the Army, Acquisition, Logistics & Technology

9:30 AM - 10:00 AM — Atrium
Break

10:00 AM - 12:00 PM — Grand Mesa DEF
Session B
Executive Panel - "How Has CMMI Improved Our Program & Project Performance - Or Has it?"
Moderator:
Mr. Mark Schaeffer, Director, Systems Engineering, OUSD(AT&L) Defense Systems and OSD Sponsor, CMMI

Panelists:
Mr. Dev Banerjee, Division Director, Systems & Flight Engineering, Boeing Integrated Defense Systems
Mr. John Evers, Raytheon Processes Program Manager, Raytheon Common Engineering Process Program
Brig Gen Gary Salisbury, USAF (Ret), Executive Director, Business Development, Defense Mission Systems, Northrop Grumman Mission Systems

12:00 PM - 1:30 PM — Grand Mesa ABC
Lunch
CMMI - State of the Model
Mr. Bob Rassa, Raytheon; ***Mr. Clyde Chittister***, SEI

1:30 PM - 5:00 PM
Technical Sessions — See Following Pages

3:00 PM - 3:30 PM — Display Area
Break

5:00 PM - 6:30 PM — Display Area
Reception

Wednesday, November 16, 2005

7:00 AM - 8:00 AM — Atrium
Registration and Continental Breakfast

8:00 AM - 5:00 PM — See Following Pages
Technical Sessions

9:30 AM - 10:30 AM — Display Area
Break

12:00 PM - 1:30 PM — Grand Mesa ABC
Lunch
Conference Best Paper Awards

3:00 PM - 3:30 PM — Display Area
Break

Thursday, November 17, 2005

7:00 AM - 8:00 AM — Atrium
Registration and Continental Breakfast

8:00 AM - 2:30 PM — See Following Pages
Technical Sessions

9:30 AM - 10:30 AM — Display Area
Break

12:00 PM - 1:00 PM — Grand Mesa ABC
Lunch

2:30 PM
Conference Adjourns

CMMI Tutorial Tracks - Monday, November 14, 2005

	Session A		Session B		Session C		Session D	
	8:00 AM		10:15 AM		1:00 PM		3 :15 PM	
Track 1 Grand Mesa D/E	*1A1 Calculating CMMI-based Return On Investment (ROI): Why, When, What, How? Mr. Rolf W. Reitzig, Cognence, Inc.*	BREAK (9:45 AM) (TUTORIAL ATTENDEES ONLY)	*1B1 Calculating CMMI-based Return On Investment (ROI): Why, When, What, How? (con't.) Mr. Rolf W. Reitzig, Cognence, Inc.*	LUNCH (12:00 PM) (TUTORIAL ATTENDEES ONLY)	*1C1 A Practical Guide to Implementing Levels 4 and 5 Dr. Rick Hefner, Northrop Grumman Corporation*	BREAK (2:45 PM) (TUTORIAL ATTENDEES ONLY)	*1D1 A Practical Guide to Implementing Levels 4 and 5 (con't.) Dr. Rick Hefner, Northrop Grumman Corporation*	RECEPTION IN DISPLAY AREA (5:00 PM) (ALL ATTENDEES)
Track 2 Grand Mesa F	*1A2 Agile/Lean Workshop Mr. Jeffrey Dutton, Jacobs Sverdrup*		*1B2 Agile/Lean Workshop (con't.) Mr. Jeffrey Dutton, Jacobs Sverdrup*		*1C2 Leveraging ITIL Services (Support and Delivery) Capability and Maturity with the CMMI Mr. Tim Kasse, Kasse Initiatives, LLC*		*1D2 Leveraging ITIL Services (Support and Delivery) Capability and Maturity with the CMMI (con't.) Mr. Tim Kasse, Kasse Initiatives, LLC*	
Track 3 Highlands	*1A3 The Look and Feel of a Successful CMMI Implementation Mr. Tim Kasse, Kasse Initiatives, LLC*		*1B3 The Look and Feel of a Successful CMMI Implementation (con't.) Mr. Tim Kasse, Kasse Initiatives, LLC*		*1C3 How to Define CMMI Based Processes That are Short and Usable Mr. Timothy G. Olson, Quality Improvement Consultants, Inc.*		*1D3 How to Define CMMI Based Processes That are Short and Usable (con't.) Mr. Timothy G. Olson, Quality Improvement Consultants, Inc.*	
Track 4 Chasm Creek	*1A4 The ROI of CMMI: Using Process Simulation to Support Better Management Decisions Dr. David M. Raffo, Portland State University*		*1B4 The ROI of CMMI: Using Process Simulation to Support Better Management Decisions (con't.) Dr. David M. Raffo, Portland State University*		*1C4 Institutionalizing Resource Planning and Management Mr. Donald A. Borcherding, NexSummit LLC*		*1D4 Institutionalizing Resource Planning and Management (con't.) Mr. Donald A. Borcherding, NexSummit LLC*	
Track 5 Mesa Verde	*1A5 Using a Measurement Framework to Successfully Achieve Measurable Results Mr. Timothy G. Olson, Quality Improvement Consultants, Inc.*		*1B5 Using a Measurement Framework to Successfully Achieve Measurable Results (con't.) Mr. Timothy G. Olson, Quality Improvement Consultants, Inc.*		*1C5 The CMMI V1.2 – An Update Mr. Mike Phillips, SEI*		*1D5 The CMMI V1.2 – An Update (con't.) Mr. Mike Phillips, SEI*	
Track 6 Wind River	*1A6 Integrated Project Management (IPM) – The CMMI and Collaborative Product Development Mr. William J. Deibler, II, Software Systems Quality Consulting - SSQC*		*1B6 Integrated Project Management (IPM) – The CMMI and Collaborative Product Development (con't) Mr. William J. Deibler, II, Software Systems Quality Consulting - SSQC*		*1C6 Requirements Engineering: A Practical Approach to Modeling and Managing Requirements Mr. William J. Deibler, II, Software Systems Quality Consulting - SSQC*		*1D6 Requirements Engineering: A Practical Approach to Modeling and Managing Requirements (con't) Mr. William J. Deibler, II, Software Systems Quality Consulting - SSQC*	

CMMI Technical Tracks - Tuesday, November 15, 2005

Track	Session/Chair	Session C 1:30 PM	Session C 2:15 PM	Session/Chair	Session D 3:30 PM	Session D 4:15 PM
Track 1 Grand Mesa D/E	***CMMI and Process Improvement*** **Mr. Brian Gallagher, SEI**	2C1 CMMI / ISO - "Can't we all just get along?" ***Mr. Dale R. Spaulding***, The Boeing Company	2C1 Layering CMMI over ISO 9000 and BS 7799: A Case Study in Improvement ***Mr. Edwin B. Smith, III***, Hart InterCivic	***CMMI and Process Improvement con't.***	2D1 Real World Application of IEEE Software Engineering Standards to CMM® /CMMI® Software Process Improvement Initiatives ***Mr. Susan K. Land***, Northrop Grumman IT/TASC	2D1 The CMMI Product Suite and International Standards – an Update ***Mr. David H. Kitson***, SEI
Track 2 Grand Mesa F	***Practical Guidance*** **Mr. Fred Schenker, SEI**	2C2 Verification in CMMI using Peer Reviews ***Ms. Jeanne H. Balsam***, Georgia Tech Research Institute	2C2 Process QA in the Information Age: Keep it Light! ***Mr. Hillel Glazer***, Entinex, Inc.	***Practical Guidance con't.***	2D2 Defect Data and Configuration Management ***Ms. Julie E. Schmarje,*** Raytheon Company	2D2 Cancel
Track 3 Highlands	***Appraisals*** **Mr. Geoff Draper, Harris Corporation**	2C3 SEI Quality Assurance Activities for CMMI Appraisals ***Mr. Will Hayes***, Software Engineering Institute	2C3 Wasted Days and Wasted Nights - Leveraging Your Appraisal Team As A Resource ***Mr. Timothy J. Davis***, Raytheon Missile Systems	***Appraisals con't.***	2D3 Building a Credible SCAMPI Appraisal Representative Sample ***Mr. Robert L. Moore, III***, Business Transformation Institute, Inc.	2D3 Top 10 Signs You're Ready (or Not) for an Appraisal ***Mr. Gary Natwick***, Harris Corporation
Track 4 Chasm Creek	***ROI & Benefits of CMMI*** **Ms. Diane Gibson SEI**	2C4 Measuring Performance: Evidence about the Results of CMMI® ***Ms. Diane Gibson***, SEI	2C4 Prioritizing Process Improvement Strategies in CMMI to Optimize Business Objectives ***Dr. Aldo Dagnino***, ABB, Inc. US Corporate Research	***ROI & Benefits of CMMI con't.***	2D4 Implementing a Plan for Controlling ROI for CMMI® Process Improvement ***Mr. J. M. Perry***, BAE Systems	2D4 Lessons Learned in the Engineering of Process Performance Models on the Journey to Higher Maturity Levels ***Dr. Mary Anne Herndon***, Transdyne Corporation
Track 5 Mesa Verde	***Acquisition*** **Mr. Jerry Fisher, The Aerospace Corporation**	2C5 Cancel	2C5 Using CMMI to raise the capability bar within Australia ***Mr. Keith Korzec***, Defense Contract Management Agency	***High Maturity***	2D5 Getting lost on the Way to Level 5 ***Ms. Kathy King***, The Center for Systems Management	2D5 Understanding Why? ***Mr. David N. Card***, Q-Labs
Track 6 Wind River	***Transitioning to CMMI*** **Mr. Hal Wilson, Northrop Grumman Corporation**	2C6 Migrating Best Practices Within an Organization: Experiences in Adapting CMMI Policies and Procedures Used In One Part of a Business to Snother ***Mr. Scott Sherrill***, Georgia Tech Research Institute	2C6 An Enterprise Wide CMMI Implementation at Accenture ***Ms. Sarah S. Bengzon***, Accenture	***Transitioning to CMMI con't.***	2D6 Stakeholder Identification and Involvement in the CMMI ***Mr. James R. Armstrong***, Systems and Software Consortium	2D6 Ensuring the Right Process is Deployed Right: Synchronizing Process Checkpoints with Business Rhythm ***Ms. Joan Weszka***, Lockheed Martin Corporation
Track 7 Wind Star	***CMMI for Small Projects and Organizations*** **Dr. Rich Turner, OSD**	2C7 Implementing CMMI in Small Businesses: A Mission Success Approach ***Mr. James E. Jones***, Support Systems Associates, Inc.	2C7 CMMI Implementation Strategies, CMMI Level 3, A small company experience, Artifact Ideas and Implementation ***Ms. Allison J. Heinen***, Mnemonics, Inc.	***CMMI for Small Projects and Organizations con't.***	2D7 Making PPQA Work on Small Projects ***Ms. Jean M. Swank***, Georgia Tech Research Institute	2D7 Does Size Matter In CMMI Implementation or Was Yoda Wrong? ***Mr. Paul H. Meyers***, SAIC

BREAK IN DISPLAY AREA (3:00 PM - 3:30 PM)

RECEPTION IN DISPLAY AREA (5:00 PM - 6:30 PM)

CMMI Technical Tracks - Wednesday, November 16, 2005

Track	Session/Chair	Session A 8:00 AM	Session A 8:45 AM	BREAK IN DISPLAY AREA (9:30 AM - 10:30 AM)	Session/Chair	Session B 10:30 AM	Session B 11:15 AM	LUNCH IN GRAND MESA ABC (12:00 PM - 1:30 PM)
Track 1 Grand Mesa D/E	***CMMI and Process Improvement*** **Ms. Lorraine Adams, SEI**	3A1 A Change Agent in a Level 1 Organization; How to Survive in a Hostile Environment ***Mr. Andrew Cordes***, ABB - United States Corporate Research Center	3A1 "Sound Systems Engineering Using CMMI®" ***Mr. Michael T. Kutch, Jr.***, SPAWAR - Charleston		***CMMI and Process Improvement con't.***	3B1 Using CMMI to "Dig Out" from an Ad Hoc Development ***Mr. Donald A. Borcherding***, NexSummit, LLC	3B1 Strategic Planning; Selling a CMMI-based Improvement Effort to Senior Management ***Dr. Aldo Dagnino***, ABB USCRC	
Track 2 Grand Mesa F	***Practical Guidance*** **Mr. Fred Schenker, CSC**	3A2 Are You Making the Most Of Your Project Schedules? ***Ms. Susan Byrnes***, PMP, Natural SPI, Inc.	3A2 Dual-Shore Program Management Experience In Packaged Solution Development, Testing & Implementation ***Mr. Rajakumard Duraimurugan***, Infinite Computer Solutions		***Practical Guidance con't.***	3B2 Keeping the Team Motivated for Success ***Mr. Michael D. Scott***, Raytheon Missile Systems	3B2 Using a Level 3 Process to Achieve CMMI Level 3 ***Mr. Stephen Ross***, Raytheon Company	
Track 3 Highlands	***Appraisals*** **Mr. Geoff Draper, Harris Corporation**	3A3 Lessons Learned in helping large and small organizations prepare for their first appraisal ***Mr. Robert J. Pomietto***, Center For Systems Management	3A3 Behind Closed Doors ***Mr. Tom G. Lienhard***, Raytheon Missile Systems		***Appraisals con't.***	3B3 CMMI Appraisal Results: The Shocking Truth Revealed ***Ms. Margaret A. Glover***, SEI	3B3 Appriasers Gone Bad ***Ms. Margaret A. Glover***, SEI	
Track 4 Chasm Creek	***ROI & Benefits of CMMI*** **Dr. Dennis Goldenson, SEI**	3A4 Evaluating the Impact New Tools and Technologies Using Simulation ***Dr. David M. Raffo***, Portland State University	3A4 The ROI Dashboard (c) : Understanding the Benefits of CMMI ***Mr. Thomas L. McGibbon***, ITT Industries, AES		***ROI & Benefits of CMMI con't.***	3B4 Quality Assurance Involvement Compared to Program Results ***Ms. Jill Brooks***, Raytheon Company	3B4 Rapidly Achieving Measurable ROI Using Early Defect Detection ***Mr. Timothy G. Olson***, Quality Improvement Consultants, Inc.	
Track 5 Mesa Verde	***High Maturity*** **Mr. Jerry Fisher, The Aerospace Corporation**	3A5 Logarithms Can Be Your Friends: Controlling Peer Review Costs ***Dr. Richard L. W. Welch***, Northrop Grumman Corporation	3A5 Journeys on the Road to Level 5 ***Mr. Joseph V. Vandeville***, Northrop Grumman Corporation		***High Maturity con't.***	3B5 Lessons Learned on the SCAMPI Road to CMMI-Software Level 5 ***Mr. Joseph N. Frisina***, BAE Systems	3B5 Merging Measurement in Mature Companies - A Success Story of Measurement Process Integration ***Ms. Sharon Rohde***, Lockheed Martin IS&S	
Track 6 Wind River	***Transitioning to CMMI*** **Mr. Hal Wilson, Northrop Grumman Corporation**	3A6 ACncel	3A6 Combining Six IPTS and Transitioning To CMMI ***Ms. Judy Overhauser-Duett***, NAVAIR		***Transitioning to CMMI con't.***	3B6 How to Transition Models and Disciplines - Looking for Transition in all the Wrong Places ***Ms. Lori G. Smailes***, TYBRIN Corporation	3B6 Using SW-CMM SQA Independent Verification as A First Step for the Transition To CMMI ***Mr. Alfredo N. Tsukumo***, CenPRA - Centro de Pesquisas Renato Archer	
Track 7 Wind Star	***Measurement*** **Mr. Jeff Dutton, Jacobs Sverdrup**	3A7 Software Size Growth and Uncertainty - Both Affect Estimate Quality and Project Risk ***Mr. Michael A. Ross***, Galorath, Inc.	3A7 COCOMO II and COQUALMO Estimation Modeling ***Mr. Qingchuan Liu***, Motorola (China) Electronics, Ltd.		***Measurement con't.***	3B7 Building an Automated System to Support Measurement in CMMI ***Dr. Richard Hayden***, Pragma Systems Corporation	3B7 Team of Three - How to get Program, Functional and Process Management Working Together ***Mr. Mark A. Marsh***, Raytheon Company	

CMMI Technical Tracks - Wednesday, November 16, 2005

	Session/Chair	Session C 1:30 PM	Session C 2:15 PM
Track 1 Grand Mesa D/E	***CMMI and Process Improvement*** **Mr. Brian Gallagher, SEI**	3C1 Enterprise Process Integration within the Space and Airborne Systems Business Area of Raytheon ***Mrs. Deana A. Seigler***, Raytheon Company	3C1 Interpreting the CMMI: It Depends! **Dr. Rick Hefner**, Seimens Corporate Research
Track 2 Grand Mesa F	***Practical Guidance*** **Mr. Paul Croll, CSC**	3C2 Accelerating Process Improvement through Collaboration: The NAVAIR Systems Process Improvement Community of Practice ***Ms. Katie Smith***, Naval Air Systems Command	3C2 What the CMMI Doesn't Say About Training (But should!) ***Mr. Sree Yellayi***, Northrop Grumman Corporation
Track 3 Highlands	***Appraisals*** **Mr. Geoff Draper, Harris Corporation**	3C3 Improving Document Reviews for Appraisals ***Mr. Kent McClurg***, Raytheon Company	3C3 Finding CMMI Compliant Artifacts and a Needle in a Haystack ***Mr. Adrio J. DeCicco***, Raytheon Company
Track 4 Chasm Creek	***ROI & Benefits of CMMI*** **Dr. Dennis Goldenson, SEI**	3C4 CMMI Process Improvement: Its not a technical problem, its a people problem! ***Mr. Rolf W. Reitzig***, Cognence, Inc.	3C4 A Project's Perspective of CMMI Level 5 ***Mr. Warren Scheinin***, Northrop Grumman Corporation
Track 5 Mesa Verde	***High Maturity*** **Mr. Jerry Fisher, The Aerospace Corporation**	3C5 The Road to Process Improvement Successes: CMMI Level 5/ISO 9001:2000 Business Model ***Mrs. Debra S. Roy***, BAE Systems National Security Solutions	3C5 Reducing Variation At Each CMMI Maturity Level ***Mr. Tim Kasse***, Kasse Initiatives, LLC
Track 6 Wind River	***CMMI Extensions*** **Mr. Randy Walters, Northrop Grumman Corporation**	3C6 Service Extensions to the CMMI ***Mr. Craig R. Hollenbach***, Northrop Grumman Corporation	3C6 Applying CMMI to Services ***Mr. Juan C. Ceva***, Raytheon ITSS
Track 7 Wind Star	***Measurement*** **Mr. Jeff Dutton, Jacobs Sverdrup**	3C7 Cancel	3C7 Parametric Project Monitoring and Control: Performance-Based Progress Assessment and Prediction ***Mr. Michael A. Ross***, Galorath, Inc.

BREAK IN DISPLAY AREA (3:00 PM - 3:30 PM)

	Session/Chair	Session D 3:30 PM	Session D 4:15 PM
Track 1 Grand Mesa D/E	***CMMI and Process Improvement con't.***	3D1 CMMI as Safeguard Against Software Entropy: A Manager's Perspective ***Dr. Thomas F. Christian, Jr.***, 402 SMXG	3D1 "Its how big? How Will You Deploy It Without Killing My Team and My Program?" ***Mr. William J. Borkowski, Jr.***, Raytheon Missile Systems
Track 2 Grand Mesa F	***Practical Guidance con't.***	3D2 CMMI GP 2.8 Interpretation and Implementation: Is This Practice Just about Numbers? ***Mr. Lseter Stamnas***, Norausky Process Solutions, Inc.	3D2 Creating Helpful Process Directives ***Mr. Kenneth I. Weinberg***, Raytheon Company
Track 3 Highlands	***Appraisals con't.***	3D3 Lessons Learned and Best Practices for Evidence Collection in Preparation for a SCAMPI Appraisal ***Mr. Ben Berauer,*** Raytheon Company	3D3 Maximizing Value for SCAMPI(SM) Preparation ***Ms. Joan Weszka***, Lockheed Martin Corporation
Track 4 Chasm Creek	**ROI & Benefits of CMMI *con't.***	3D4 Achieving the Promised Benefits of CMMI ***Dr. Rick Hefner***, Northrop Grumman Corporation	3D4 Measuring Economic Benefits of Process Improvement in CMMI Level 1 Organizations ***Dr. Aldo Dagnino***, ABB, Inc. US Corporate Research
Track 5 Mesa Verde	***High Maturity con't.***	3D5 Ways to Ensure the Culture Supports Level 5 ***Mr. Warren Scheinin***, Northrop Grumman Corporation	3D5 Analyzing Defects Can Tell a Story About a Company ***Ms. Diane A. Mizukami-Williams***, Northrop Grumman Mission Systems
Track 6 Wind River	***CMMI Extensions con't.***	3D6 Management Challenges & Lessons Learned Implementing CMMI in a Services Environment ***Mr. Thomas E. Zience***, BAE Systems Information Technology	3D6 CMMI v1.1 for a Service Oriented Organization ***Mr. Steven K. Hall***, Raytheon Corporation
Track 7 Wind Star	***Measurement con't.***	3D7 Measuring and Estimating Process Performance ***Dr. Richard D. Stutzke***, SAIC	3D7 Cancel

ADJOURN FOR THE DAY

CMMI Technical Tracks - Thursday, November 17, 2005

Track	Session/Chair	Session A 8:00 AM	Session A 8:45 AM		Session/Chair	Session B 10:30 AM	Session B 11:15 AM	
Track 1 Grand Mesa D/E	***CMMI and Process Improvement*** **Mr. Brian Gallagher, SEI**	4A1 “Barrier Busting” – Obtaining Active Leadership Support ***Mr. Michael D. Scott***, Raytheon	4A1 Cancel	**BREAK IN DISPLAY AREA (9:30 AM - 10:30 AM)**	***CMMI and Process Improvement con’t.***	4B1 Don’t Waste Time Writing the Wrong Processes ***Ms. Suzanne B. Zampella***, The Center for Systems Management	4B1 Contrasting CMMI and the PMBOK ***Mr. Wayne Sherer***, Anteon Corporation	**LUNCH IN GRAND MESA ABC (12:00 PM - 1:00 PM)**
Track 2 Grand Mesa F	***Practical Guidance*** **Mr. Paul Croll, CSC**	4A2 Supplier Management Strategy Considerations with CMMI ***Dr. Rick Hefner***, Northrop Grumman Corporation	4A2 Simplifying Process Tailoring To Project Execution ***Mr. Howard T. Kaplan***, Raytheon Company		***Practical Guidance con’t.***	4B2 CMMI and Agile: A High Tech R&D Success Story ***Mr. Gene Miluk***, SEI	4B2 How to Incorporate “Lessons Learned” for Sustained Process Improvements ***Mr. Anil K. Midha***, BAE Systems	
Track 3 Highlands	***Appraisals*** **Mr. Geoff Draper, Harris Corporation**	4A3 Techniques for Shortening the Time and Cost of CMMI Appraisals ***Mr. Sam Fogle***, Systems and Software Consortium, Inc.	4A3 Using Classified Programs in CMMI Appraisals ***Mr. Kenneth I. Weinberg***, Raytheon Company		***Appraisals con’t.***	4B3 The best intentions of SCAMPI V1.1; what we meant and what they heard ***Mr. Will Hayes***, SEI	4B3 Success the First Time: How to Get the Rating You Want or How to Fool Your Lead Appraiser ***Mr. Paul H. Meyers***, SAIC	
Track 4 Chasm Creek	***ROI & Benefits of CMMI*** **Dr. Dennis Goldenson, SEI**	4A4 The Effects of CMMI® on Program Performance ***Mr. Joseph P. Elm***, SEI	4A4 Squeezing Variation for Profit ***Mr. Donald R. Corpron***, Northrop Grumman Corporation		***SCAMPI B/C***	4B4 Process In-Execution Review (PIER) for Contract Monitoring ***Ms. Lorraine J. Adams***, SEI	4B4 Planning a SCAMPI C Appraisal from a Strategic Perspective ***Mr. John P. Kennedy***, The MITRE Corporation	
Track 5 Mesa Verde	***High Maturity*** **Mr. Jerry Fisher, The Aerospace Corporation**	4A5 Cancel	4A5 A Statistical Approach To Product Quality Assurance ***Mr. Randall J. Varga***, BAE Systems		***High Maturity con’t.***	4B5 A Key to a High Maturity Rating is - ORGANIZATION ***Mrs. Karen M. Pelletier***, Northrop Grumman Corporation	4B5 Extending CMMI Level 4/5 Organization Metrics Beyond Software Development ***Ms. Linda R. Brooks***, Northrop Grumman Corporation	
Track 6 Wind River	***CMMI Extensions*** **Mr. Randy Walters, Northrop Grumman Corporation**	4A6 Tailoring CMMI for Use in an IT Services Environment ***Ms. Stacy Savage***, BAE Systems Information Technology	4A6 Interpretation of CMMI for Outsourcing and Associated Measures ***Dr. Hubert Hofmann***, General Motors		***CMMI Extensions con’t.***	4B6 How to Become Your Customer’s Software Provider Of Choice ***Mr. David Herron***, DCG, Inc.	4B6 CMMI® and Process Improvement at the LA AFB Space and Missile Center (SMC) ***Mr. Keith Wright***, SPARTA, Inc.	
Track 7 Wind Star	***Systems Engineering*** **Mr. Mike Phillips, HSBC**	4A7 Practical Experiences and Lessons Learned In Implementing CMMI ***Ms. Sandee D. Guidry***, TECHSOFT	4A7 Cancel		***Systems Engineering con’t.***	4B7 Systems Engineering Influence Throughout the CMMI ***Mr. Tim Kasse***, Kasse Initiatives, LLC	4B7 Does Process Capability buy Product Assurance? – Implications for Safe and Secure Systems ***Mr. Paul R. Croll***, CSC	

CMMI Technical Tracks - Thursday, November 17, 2005

	Session/Chair	Session C 1:00 PM	Session C 1:45 PM
Track 1 Grand Mesa D/E	***CMMI and Process Improvement*** **Mr. Gene Miluk, SEI**	4C1 Being Customer Oriented ***Mr. Tim Kasse***, Kasse Initiatives, LLC	4C1 Learning from Lessons Observed- - Mitigating Resistance to Process Improvement ***Mr. Bob Norris***, National Geospatial-Intelligence Agency
Track 2 Grand Mesa F	***Practical Guidance*** **Lorraine Adams, SEI**	4C2 Cancel	4D2 Data Management: The Hidden Enabler or (The Key Data and Work Product Integrator) ***Mr. Lester Stamnas***, Norausky Process Solutions, Inc.
Track 3 Highlands	***Appraisals*** **Mr. Geoff Draper, Harris Corporation**	4C3 Quantitative Comparison of SCAMP A, B, and C ***Mr. Dan Luttrell***, Northrop Grumman Mission Systems	4C3 Performing standard and consistent global appraisals in large multi-cultural organizations ***Ms. Jeanine Courtney-Clark***, Integrated System Diagnostics, Inc.
Track 4 Chasm Creek	***SCAMPI B/C*** **Mr. Jerry Fisher, The Aerospace Corporation**	4C4 Critical Path SCAMPIs: Getting Real Business Results from Appraisals ***Mr. Michael J. West***, Natural SPI, Inc.	4C4 Using a SCAMPI C for Collective Improvement Across a Multi-Business Program ***Mr. Oktawian Nowak***, Motorola, Inc.
Track 5 Mesa Verde	***High Maturity*** **Mr. Andrew Boyd, Northrop Grumman Corporation**	4C5 Paladin Drives Forward to CMMI Maturity Level 5 ***Mr. Victor Elias, M.S***, Armament Software Engineering Center, US Army	4C5 Business Improvements Achieving CMMI(R) Level 5 at SAIC: Who Moved My Process? ***Ms. Sharon Cobb Flanagan***, SAIC
Track 6 Wind River	***CMMI Extensions*** **Mr. Randy Walters, Northrop Grumman Corporation**	4C6 Software Outsourcing with CMMI ***Dr. John W. Mishler***, SEI	4C6 Cancel
Track 7 Wind Star	***Systems Engineering*** **Mr. Jeff Dutton, Jacobs Sverdrup**	4C7 Future of Software Engineering Project Management and the CMMI ***Dr. Kenneth E. Nidiffer***, Systems and Software Consortium	4C7 Cancel

Thank you for attending the 5th Annual CMMI Technology Conference and User Group

Thank you for displaying at the 5th Annual CMMI Technology Conference & User Group

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Lessons Learned and Best Practices for Evidence Collection in Preparation for a SCAMPI Appraisal

Presented to National Defense Industrial Association
5th Annual CMMI Technology Conference and User Group
Denver, Colorado

Ben Berauer, Raytheon
With contributions by Sandy Emers and
the Raytheon St. Petersburg Enterprise Process Group
November 14-17, 2005

Presentation Outline

- Methodologies and approaches
- Lessons learned
- Best practices for appraisal preparation and evidence collection
- Summary take-aways

Methodologies and Approaches Taken

- Program scorecard based on Objective Evidence (OE)
  - Collecting and documenting OE follows a disciplined data collection and scorecarding process
  - Customizing the appraisal tool to meet the collection process
  - PIID building using appraisal tool with direct linkage into organizational Process Asset Library
- Evidence verification
  - Collecting the right direct and indirect evidence
  - Focusing on the required (expected) evidence … don't try to inundate with unessential data or "almost" the right thing
  - Identifying evidence using OE Collectors, FARs, Verifiers
- Gap analysis and closure
  - Detailing action plans targeting identified deficiencies
  - Collecting OE until specified scoring criteria are met

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Pre-Appraisal Scorecarding

Scope & Prepare for Scorecarding

- Scope appraisal
- Select preparation methods
- Select tools
- Develop plans

Team Preparation

Set up OE Collector and Verifier teams

Obtain & Analyze Objective Evidence

- Identify Objective Evidence
- Collect Objective Evidence
- Assess and scorecard

OE Collection Guidance

Collection and Scorecarding Procedure

Scorecarding using appraisal tool

Develop Action Plans

Implement Action Plans

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Methodologies and Approaches Taken - 2

- Evidence collectors
  - Populate appraisal tool with appropriate direct and indirect OE
  - Tag data when linked to a practice
- Evidence verifiers
  - Review each practice for adequate evidence based on program scope, discipline responsibilities, etc.
  - Tag data to indicate verification results
  - Mentor evidence collectors
- Class C and B appraisals validate that right evidence was provided
  - Tag data to indicate practice implemented and evidence is satisfactory
- Loop through above steps as needed until the right evidence is captured
  - Tagging at each step of process ensures closure on any evidence issues

“Evidence Tracking/Tagging” Flow

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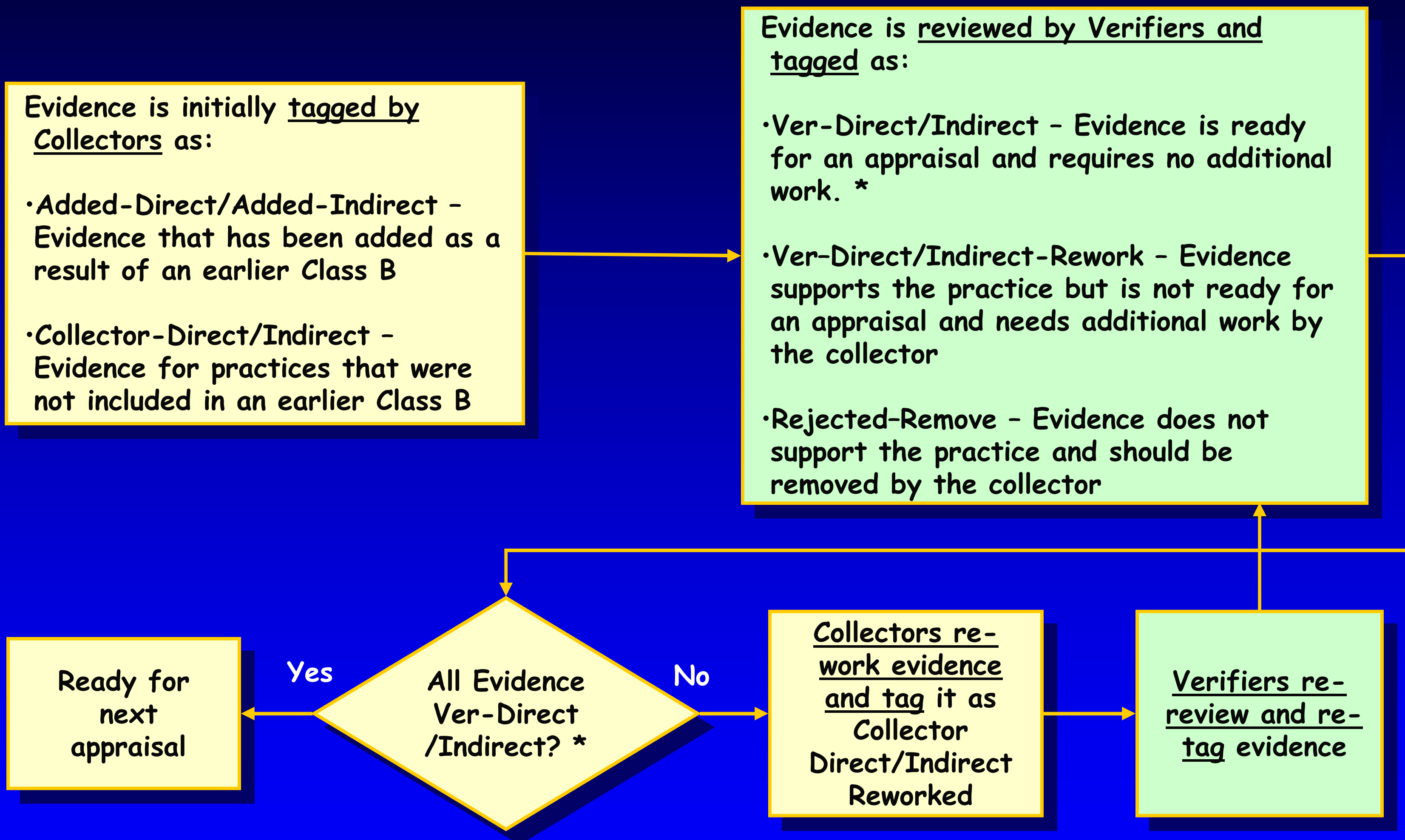

* Evidence that has an “Evidence Type” flag of Direct(A) or Indirect(B) was accepted in an earlier Class B. For this effort, this evidence is considered verified and will not be reviewed by the verifiers.

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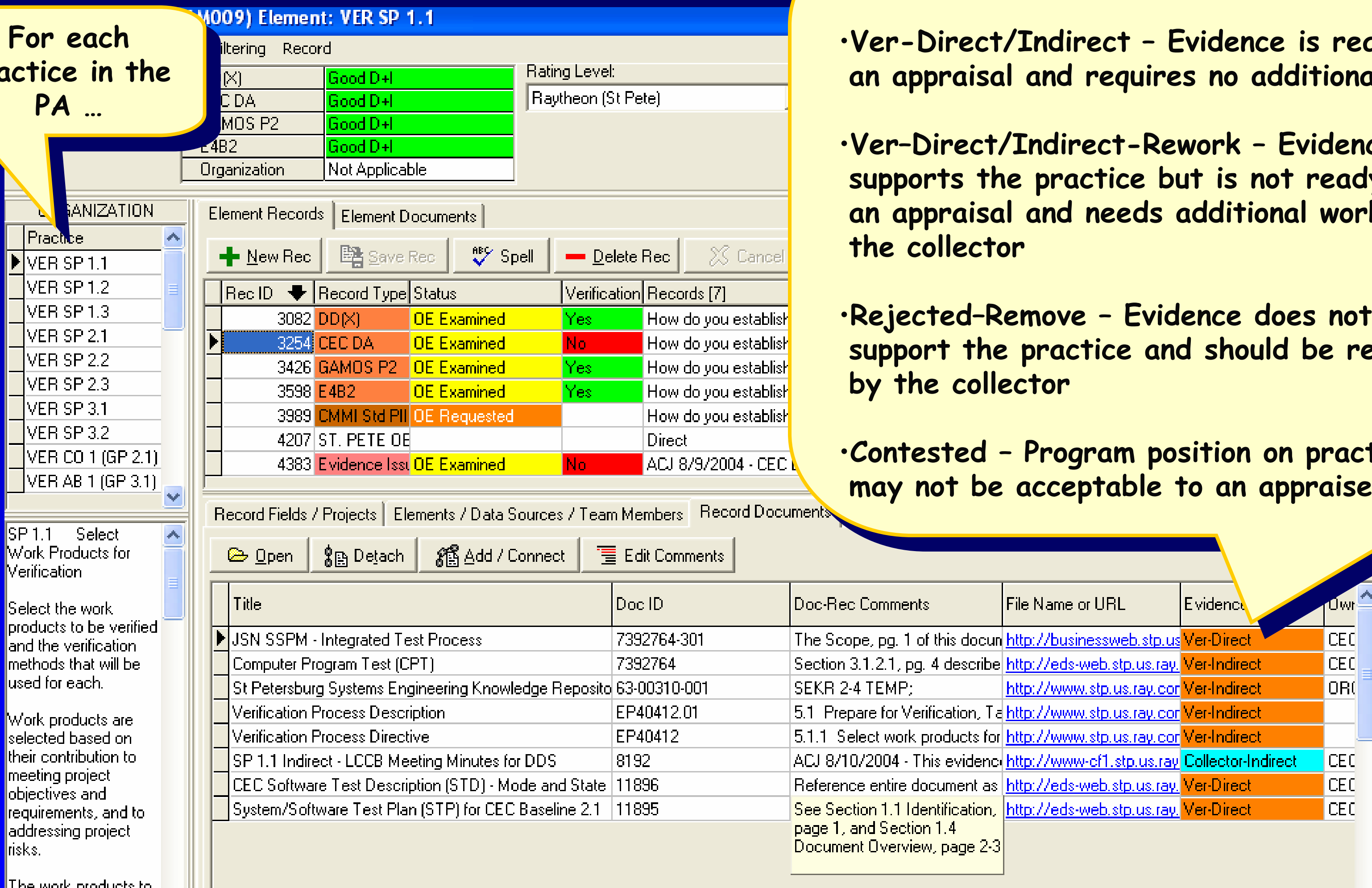
"Evidence Type" Tagging

For each practice in the PA …



Verifier reviews the evidence and rates it:

- Ver-Direct/Indirect – Evidence is ready for an appraisal and requires no additional work.
- Ver-Direct/Indirect-Rework – Evidence supports the practice but is not ready for an appraisal and needs additional work by the collector
- Rejected-Remove – Evidence does not support the practice and should be removed by the collector
- Contested – Program position on practice may not be acceptable to an appraiser

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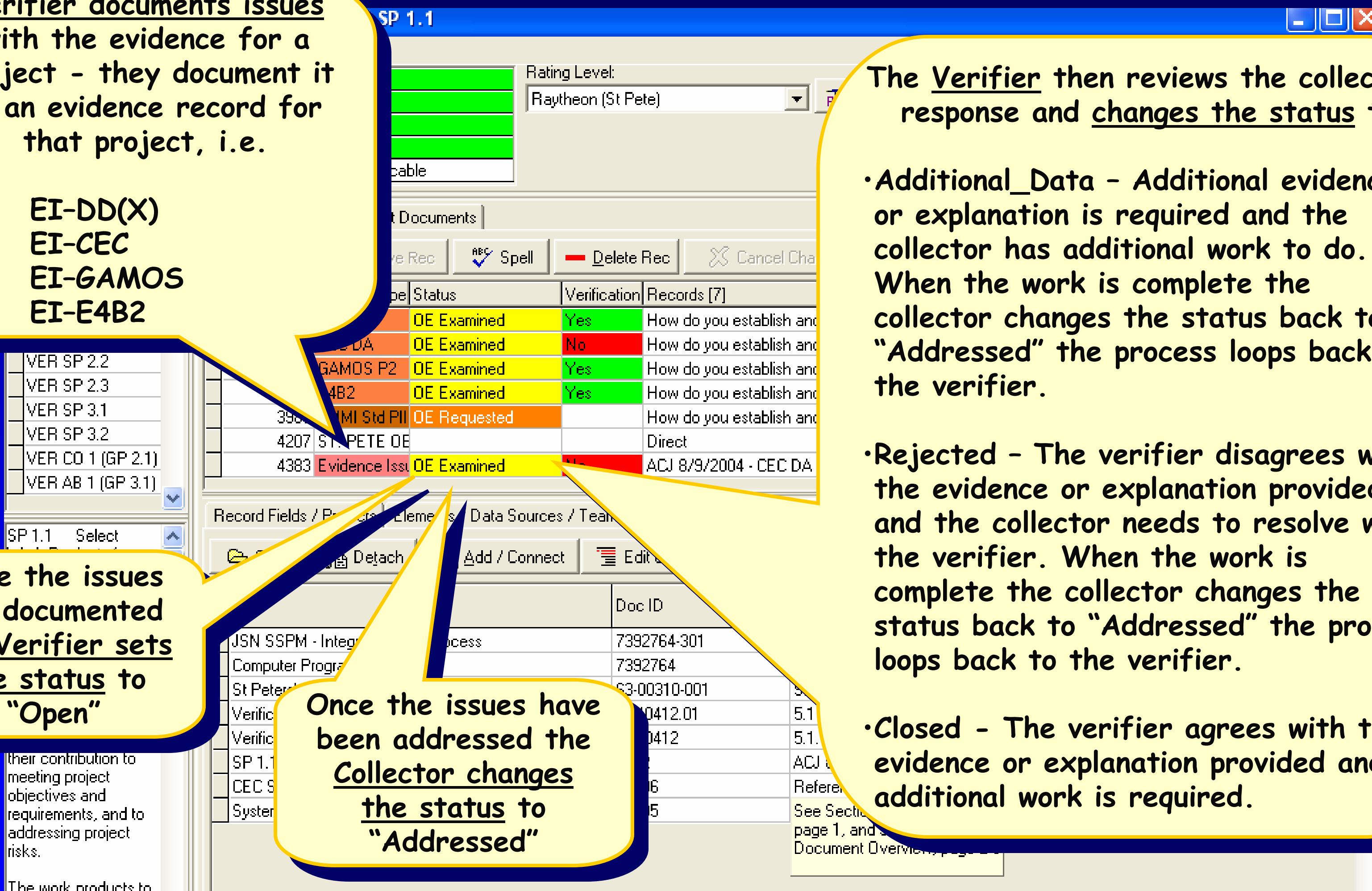
Evidence Issues Process



<u>Verifier documents issues</u> with the evidence for a project – they document it in an evidence record for that project, i.e.

EI-DD(X)
EI-CEC
EI-GAMOS
EI-E4B2

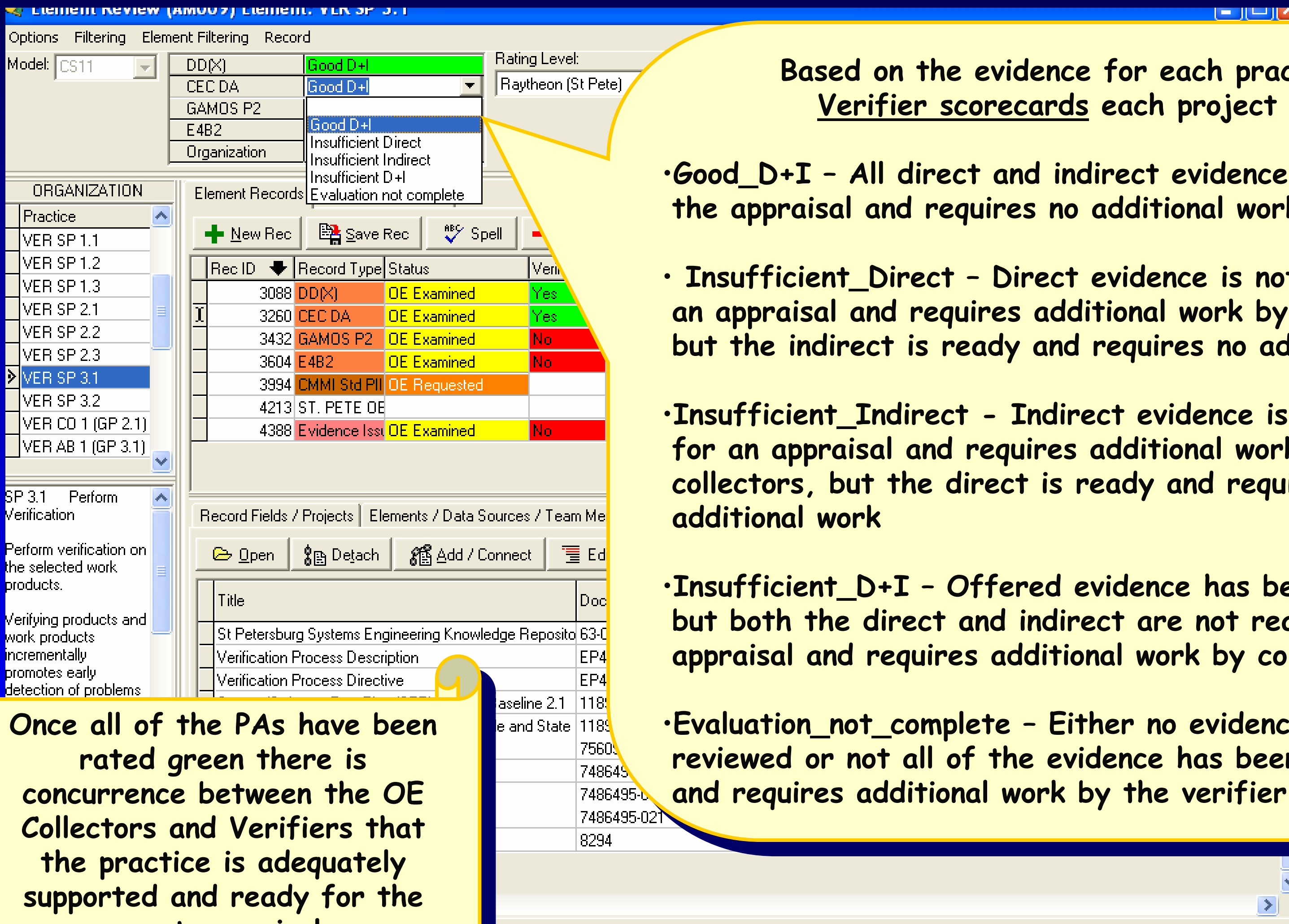
Once the issues are documented the <u>Verifier sets the status</u> to "Open"

Once the issues have been addressed the <u>Collector changes the status</u> to "Addressed"

The <u>Verifier</u> then reviews the collectors response and <u>changes the status</u> to:

- Additional_Data – Additional evidence or explanation is required and the collector has additional work to do. When the work is complete the collector changes the status back to "Addressed" the process loops back to the verifier.
- Rejected – The verifier disagrees with the evidence or explanation provided and the collector needs to resolve with the verifier. When the work is complete the collector changes the status back to "Addressed" the process loops back to the verifier.
- Closed – The verifier agrees with the evidence or explanation provided and no additional work is required.

Verification Process (cont.)



Based on the evidence for each practice, Verifier scorecards each project as:

- *Good_D+I* – All direct and indirect evidence is ready for the appraisal and requires no additional work
- Insufficient_Direct – Direct evidence is not ready for an appraisal and requires additional work by collectors, but the indirect is ready and requires no additional work
- Insufficient_Indirect – Indirect evidence is not ready for an appraisal and requires additional work by collectors, but the direct is ready and requires no additional work
- Insufficient_D+I – Offered evidence has been reviewed, but both the direct and indirect are not ready for an appraisal and requires additional work by collectors
- Evaluation_not_complete – Either no evidence has been reviewed or not all of the evidence has been reviewed and requires additional work by the verifier

Once all of the PAs have been rated green there is concurrence between the OE Collectors and Verifiers that the practice is adequately supported and ready for the next appraisal

Program B Stoplight Status

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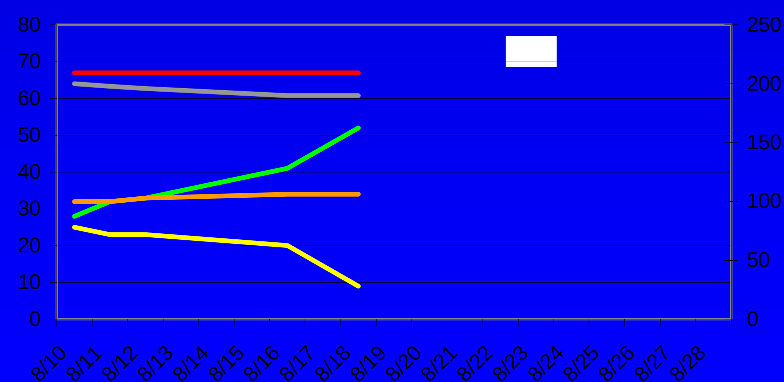
	Resp	Sched	CO	AB					DI				VE		SP													
PA			1	1	2	3	4	5	1	2	3	4	1	2	1	2	3	4	5	6	7	8	9	10	11	12	13	14
REQM	Jost	16-Aug													1.1	1.2	1.3	1.4	1.5									
PP	Louthan														1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	2.5	2.6	2.7	3.1	3.2	3.3
PMC	Louthan														1.1	1.2	1.3	1.4	1.5	1.6	1.7	2.1	2.2	2.3				
SAM	Louthan														1.1	1.2	1.3	2.1	2.2	2.3	2.4							
M&A	Ruhlman														1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4						
PPQA	Jost	18-Aug													1.1	1.2	2.1	2.2										
CM	Jost	19-Aug													1.1	1.2	1.3	2.1	2.2	3.1	3.2							
RD	Jost	17-Aug													1.1	1.2	2.1	2.2	2.3	3.1	3.2	3.3	3.4	3.5				
TS	Ruhlman														1.1	1.2	1.3	2.1	2.2	2.3	2.4	3.1	3.2					
PI	Ruhlman	13-Aug													1.1	1.2	1.3	2.1	2.2	3.1	3.2	3.3	3.4					
VER	Jost	11-Aug													1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2						
VAL	Jost	13-Aug													1.1	1.2	1.3	2.1	2.2									
OPF	Ruhlman														1.1	1.2	1.3	2.1	2.2	2.3	2.4							
OPD	Ruhlman														1.1	1.2	1.3	1.4	1.5									
OT	Ruhlman														1.1	1.2	1.3	1.4	2.1	2.2	2.3							
IPM	Louthan	20-Aug													1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3						
RSKM	Louthan														1.1	1.2	1.3	2.1	2.2	3.1	3.2							
DAR	Louthan	20-Aug													1.1	1.2	1.3	1.4	1.5	1.6								

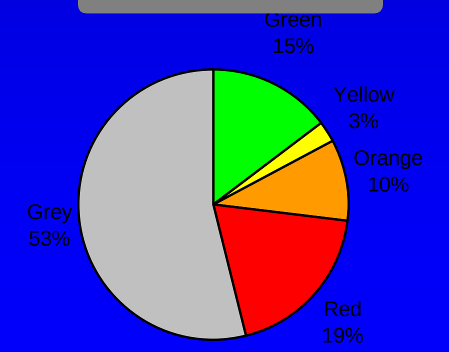
Legend/Count

NAME	
Good D+I	52
Insufficient Direct	9
Insufficient Indirect	34
Insufficient D+I	67
Evaluation not complete	190

Trend



Current



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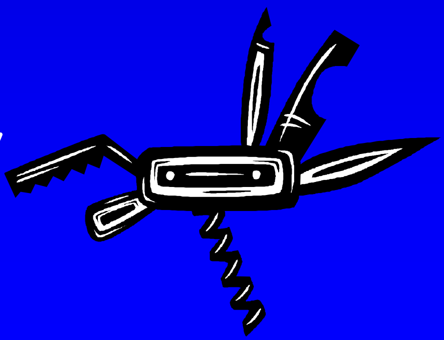
Lessons Learned

- Appraisal preparation requires tooling
  - Flexible appraisal tools supporting preparation are very important
  - Tool must be flexible and configurable
- Use the same tools for appraisal preparation and the appraisal
  - Scorecard readiness using the appraisal tool
  - Using the tool as a window to the organization's PAL (not a separate collection of evidence)
- Tools are not enough
  - Need to have scorecarding requirements and features defined
  - Need a well thought out scorecarding process that is both implemented and followed
  - Appraisal tools did not adequately support appraisal preparation right out of the box
- Every tool has it's bugs and hidden "features"
  - Need tool "wizard" to ensure features are implemented, and ensure any tool problems do not affect progress



Lessons Learned (cont.)

- You may not always have the right people collecting data
  - Collectors of program OE must have program data repository and work product knowledge
  - FARs must be the ones that do the work and are familiar with how they do it and what they produce
  - Evidence verifiers must be familiar with needed OE
  - What you see is what you get … OE collected must support FAR story (This connection is **KEY** to the success of the appraisals)
  - Evidence collectors may not be FARs !!??
    - FARs are typically key program personnel
    - Programs are resistant to dedicate key program personnel to OE collection
    - FARS must see / understand collected evidence

Best Practices – Evidence Collection (1)

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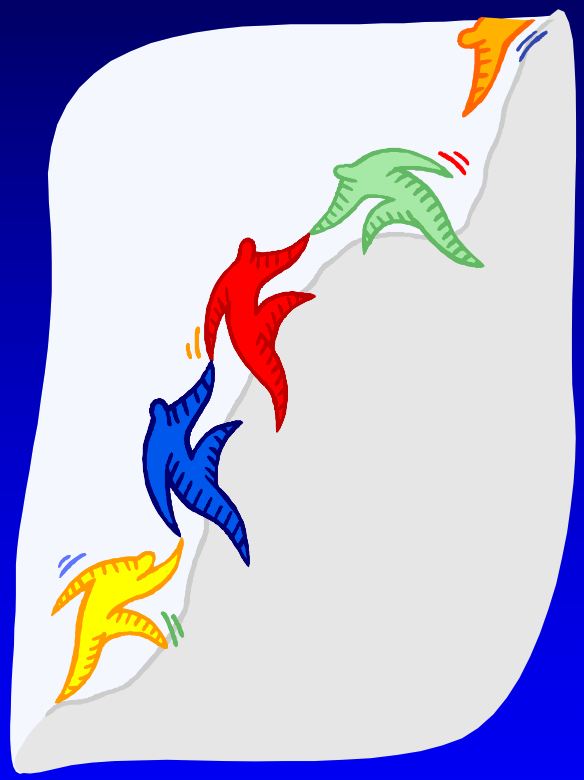
- Use PIID questions to guide the process
  - Guides the collection team to what needs to be collected for a given program
  - Shows compliance with the org processes by answering the question for your program, for each practice,
  - Provides discipline and/or support function specific unique answers, if applicable
  - Explains any life-cycle or other program considerations that affect how the practice is implemented, and the evidence to support them
  - Weaves the story of how it is done, and what work products are produced, and then provide those work products as evidence



Best Practices – Evidence Collection (2)

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- Focusing on the principle "direct evidence", the rest will come
  - Started with both direct and indirect evidence collection direction
  - Found the indirect evidence usually came naturally
- Focusing on providing the major program work products as evidence everywhere they applied
  - SDP, SEMP, PMP, IMP/IMS, etc.
- Building evidence threads across practices and even process areas
  - Especially for the GPs
- Look for consistency with organization procedures
  - Keep a cross-program focus for consistency and common evidence

Best Practices – Evidence Collection (3)

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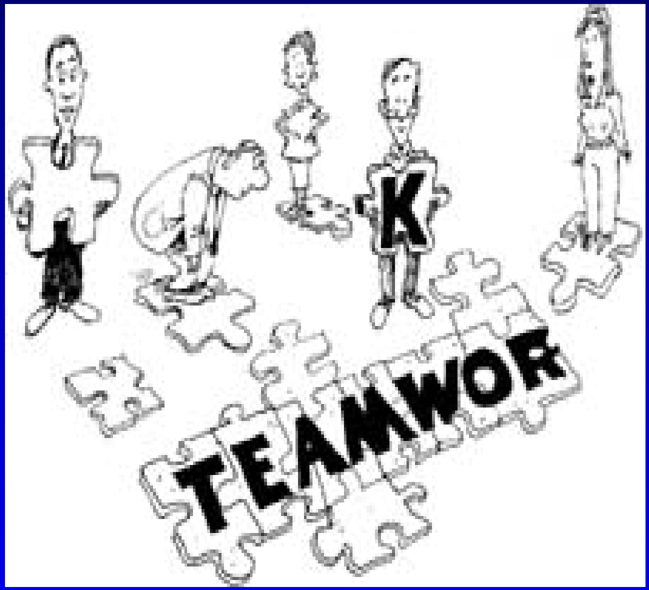
- A close working relationship between the program's FAR, the Verifier, and the evidence collectors
  - Evidence Collectors and FARs provide program expertise in work products produced
  - Verifiers provide CMMI model/method, Organizational Process expertise, and evidence coordination
  - OE supports what the FARs describe as standard practices, and the model!
  - Team review of expected work products for each model practice



Best Practices – Evidence Review

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- Reviewing evidence across programs to ensure consistency
  - Understand the organizational standard process, and focus on common program responses, explaining any tailoring or program unique behaviors
  - Identifying and ensuring all programs had similar “right” data
- Identify where evidence does not exist, and needs to be produced !!!!!!
  - shouldn’t be too many cases of non-existent data
- Review regularly and provide corrective action feedback promptly
  - Drive the evidence collection to completion, and get the right stuff!

Best Practices –
Preparation Monitoring and Control

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- Monitor and report status of every practice
- Review with appropriate management drives the process
  - This can be both a positive and negative driver
- Know your status at all times
- Maintain action item and action plan status
  - Ensure that all 'to do's" get done promptly
  - Plan appropriate correction actions plans to address issues
  - Set due dates that achieve the desired result
  - Identify and track risks, and develop risk mitigation plans
- Collect OE until you meet specific scoring criteria
  - Iterate process until ready for appraisal

In Summary

- Collecting and documenting OE requires a well defined and disciplined process, just like the appraisal
- Objective Evidence PIID's are central in how we prepare for the appraisals
- Appropriate tools can greatly facilitate preparation
  - Using the same tools for preparation and the appraisal is a big plus
- Determining if a project's OE is appropriate and adequate is ultimately left up to CMMI appraisers
  - But developing appropriate OE database is key to preparing for the appraisal

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Supplemental Charts

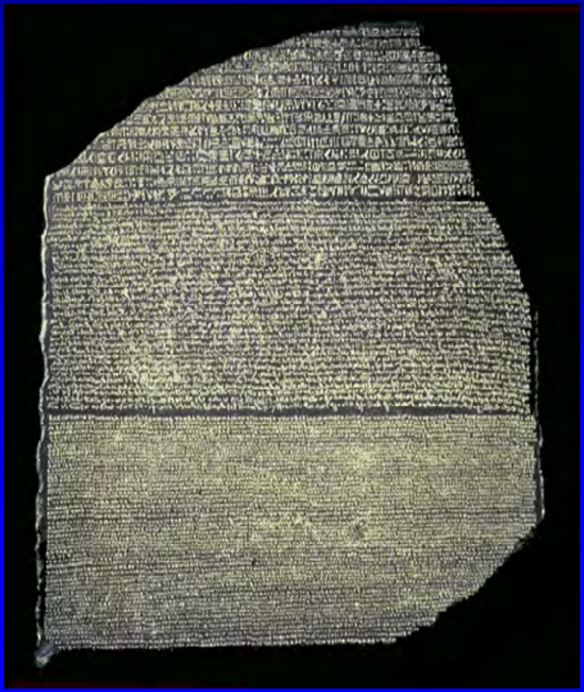
Section Divider

Some Terms Used

Appraisal Scorecard: A scorecard showing how well prepared for an appraisal a program is. Can be OE focused (Do we think we have the right evidence).

Scorecarding: The procedural steps followed to collect, validate, monitor, and control preparations using a scorecard.

PIIDs: Practice Implementation Indicator Database showing what OE your organization and programs expect for each practice of the CMMI Model, and what each program has to meet that expectation.



Using CMMI to Dig Out from Ad Hoc Practices

10-15-05

NexSummit LLC 908-684-8914 nexsummit.com

Overview

- SW Project Overview
  - Deployed Quickly
  - Not enough testing
  - A lot of unhappy customers
- Result
  - 20 SW Splinters
  - Overwhelmed with maintenance
  - Created more problems

Recovery Plan

- It was clear there was a problem
  - Gain support to use process
- Define Processes and Procedures to Recover
  - SW Helpdesk
- Train the Organization on the new processes

Recovery Plan

- Establish a method to review, prioritize and approve SW issues
  - Helpdesk Review Team
- Make sure each Issue is clearly defined
  - Consistent bug Reporting
- Plan the releases for approved issues
  - Assigned a Project Manager
- Monitor the execution to the Plan
  - Weekly Meetings

Recovery Plan

- Design and Implement the solutions
  - Developed a streamlined process
- Integrate solutions into a SW Release
  - SW Group Leader coordinated integration
- Verify the solution works
  - Test Report Required
- Configuration Management
  - SW Release was controlled with CM SW

Recovery Plan

- Validate the SW Release
  - SQA Group
    - Performed audits and system testing on CM Controlled Release
    - Performed audits of the process
    - Conducted Lessons Learned
    - Collected metrics monthly

Organization Process Focus

- SP1.1-1 Establish Organization Process Needs
  - Better methods to collect SW issues
  - Review the issues received
  - Track and close issues being worked on
  - Better development methods

Organization Process Focus

- SP1.1-2 Appraise Organization' Processes
  - Strengths
    - Good Skills. Well trained on the development environment/tools
    - Consistently used CM system. All splinters were controlled
  - Weaknesses
    - Bug reporting system was difficult to use
    - Bug reporting system was not being used

Organization Process Focus

- SP1.3-1Identify the Organization Process Improvements
  - Web based SW Helpdesk
  - The Helpdesk Database was tied to the CM System
  - Rotated SW Engineers through Helpdesk
  - Instituted a Review Team
  - Developed an escalation procedure
  - Project Manager coordinated customers and SW team

Organization Process Focus

- SP2.1-1 Establish Process Action Plans
- SP2.2-1 Implement Process Action Plans
- SP2.3-1 Deploy Organizational Process Assets
  - SW Helpdesk Procedure
  - SW Escalation Procedure
  - SW Planning and Numbering Procedure
  - SW Installation Procedure

Organization Definition

- Establish Standard Processes
  - SW Helpdesk Procedure
    - Defined Helpdesk as a repository not an escalation path
    - Defined the CM system as the repository. All issues and revisions were controlled. Also had a web interface.
    - Defined the role of the Helpdesk. Verify Information is complete, assign CR number.
    - Defined the role of the Expert. Verify that the report was technically complete
    - Defined the role of the Review Team. Set priority and defined the scope of work.

Organization Definition

- Establish Standard Processes
  - SW Helpdesk Procedure
    - Defined the role of the Project Manager. Plan SW Releases based on priorities and customer needs.
    - Defined the role of the SW Group Leader. Assign issues to developers with the right skill set.
    - Defined the methods used to track the issue through the development process.
    - Defined the steps to enter an issue via the web site.

Organization Definition

- Establish Standard Processes
  - SW Escalation Procedure
    - Defined what an escalation is. Safety or Severe
    - Defined a single point contact
    - Defined the methods to report an escalation
  - SW Planning and Numbering Process
    - Defined … eme. New scheme required … s while merging splinters
    - X.XXX A1

Alpha Releases used to Beta SW to a specific customer before merging into the trunk

Organization Definition

- Establish Standard Processes
  - SW Installation Procedure
    - Lessons Learned revealed that many of the reported issues were due to installation problems.
      - Incorrect Installation
      - Couldn't back out the software
    - Defined how to Back up Files
    - Defined How to Install new SW
    - Defined Trouble Shooting methods and work-arounds
    - Defined how to Back out the SW
    - Defined metrics to track successful installations and escalations

Organizational Training

- SG1 Establish Organization Training
- SG2 Provide Necessary Training
  - Training provided to the Rotating Helpdesk members, the Experts, and the Developers
  - Training on the website interface was provided to the users who will be reporting issues to helpdesk
  - Training records were maintained

Project Planning

- SP1.1-1 Establish the Scope of the Project
  - The Project Manager…
    - Used the severity rating assigned by the Review Team to identify the which issues would be addressed in each release
    - Communicated the plan to the customers
    - Negotiate scope if necessary

Project Planning

- SP1.2-1 Establish Estimates
  - The Review Team used three categories to size the effort
    - Category 1: Bug Fix
    - Category 2: Small Feature
    - Category 3: Large Feature
  - The Project Manager used 5, 20 and 40 days to estimate the effort
    - Avoids interrupting the SW Developers for estimates

Project Planning

- SP1.3-1 Define Project Life Cycle
  - The Helpdesk Procedure defined the Life Cycle:
    - Open – Initial Setting
    - In Expert Review - Helpdesk
    - In Issue Review - Expert
    - In Planning – Review Team
    - In Development – Project Manager
    - Ready to Merge – SW Developer
    - In SQA – SW Group Leader
    - Complete – SQA Group Leader

Project Planning

- SG2 Develop Project Plan
  - The Project Manager is responsible for compiling plan.
  - Main risk was that the category selected was incorrect. Issues were re-estimated when assigned for correction.
  - All work products were linked to the Helpdesk entry.
  - Resources were reviewed on a monthly basis
  - Skill sets were reviewed monthly.
  - Stakeholders reviewed the plan and Project Manager acquired necessary approvals.

Project Monitor and Control

- SG1 Monitor Project Against Plan
  - – Project Manager conducted weekly meetings to monitor progress.
  - – Problems identified.
    - Resource limitations: People or Equipment
- SG2 Manage Corrective Action to Closure
  - – Resources were addressed
  - – Customer was notified in advance when a delay was likely.

Requirements Management

- SG1 Manage Requirements
  - All software issues are entered into helpdesk with a standardized report form.
  - The Review Team verified the information was complete and accurate before committing.
  - All changes were made through Helpdesk and were under CM control.
  - Project Manager tracked that each issue was assigned.
  - SQA tracked that each issue in the plan was included and closed.

Requirements Development

- SG1 Develop Customer Requirements
  - Helpdesk entries were used as the customer requirements
- SG2 Develop Product Requirements
  - SW Requirements were developed fro CAT2 and 3 projects
- SG3 Analyze and Validate Requirements
  - Analysis was performed by the expert prior to submission to the Review Team.
  - Review Team was the final validation step.

Technical Solution

- SG1 Select Product Components Solution
  - Primarily applied to Category 3 projects
- SG2 Develop Design
  - Designs were develop for Category 2 and 3
- Implement the Product Design
  - SW code
  - SW Test Results
  - SW Release Notes

Product Integration

- SG1 Prepare for Product Integration
  - The SW Group Leader developed the Integration Plan.
  - The Project Manager track progress.
- SG2 Ensure Interface Compatibility
  - The SW Group Leader was responsible for reviewing SW deliverables and interface compatibility
- SG3 Assemble Product Components and Deliver Product
  - The SW Group Leader coordinated build machines for the final build and SW delivery.

Verification

- SG1 Prepare for Verification
  - The SW Engineers are required to develop a Test Plan for all three category projects
- SG2 Perform Peer Reviews
  - Peer Reviews are conducted for Category 3
  - SW Group Leaders review work products for Category 1 and 2 projects
- SG3 Verify Selected Work Products
  - Software Engineers are responsible for verifying work products and documenting Test Results

Validation

- The SQA is responsible for validating the SW Release
  - Validate all issues promised are included in the release
  - Auditing Test Results
  - Validating general software performance
  - Burning and validating the SW Installation CD and procedure
  - Writing the ECR to release the SW to Production

Configuration Management

- All work products are maintained under SW Configuration Control.
- All SW changes are tracked using SW Configuration Management
- Configuration Management records are maintained by SQA.

Results

- Escalations
  - SW Metrics identified SW Installation was a major problem
  - Creation and Improving the SW Installation procedure reduced escalations drastically

Results

- SW Helpdesk
  - Metrics showed more issues were being closed than new reports
  - New Reports continued as Operators used features that they didn't dare try before.
- SW Deliveries
  - Release that were 1 to 2 months late were now delivered on time.

Conclusions

- Using process to recover from ad hoc development:
  – Increased Quality
  – On-time Delivery
  – Improved Customer Satisfication
  – Improved Team Morale

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Raytheon

How Big is it?

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Organization and Accomplishments

Raytheon Missile Systems, Headquarters Tucson, AZ

- **Employees: 11,000**
- **’04 Sales: $3.8 B**
- **World Largest Appraised SEI CMMI Level 3 Organization December 2004**
- **SW-CMM Level 5 in November 2001**

Key elements of our approach

GOAL:
Obtain CMMI certification at level 3
- Opportunity for future growth
- Win discriminator for RMS & Raytheon
- Improved Program performance

- **Understand the importance of having a simplified, integrated product development architecture**
- **Understand the need to create a detailed plan, agreed to by all stakeholders, before beginning execution**
- **Learn one approach to showing value to programs & improving their performance**

Sound architecture, agreed to deployment plan, value to program

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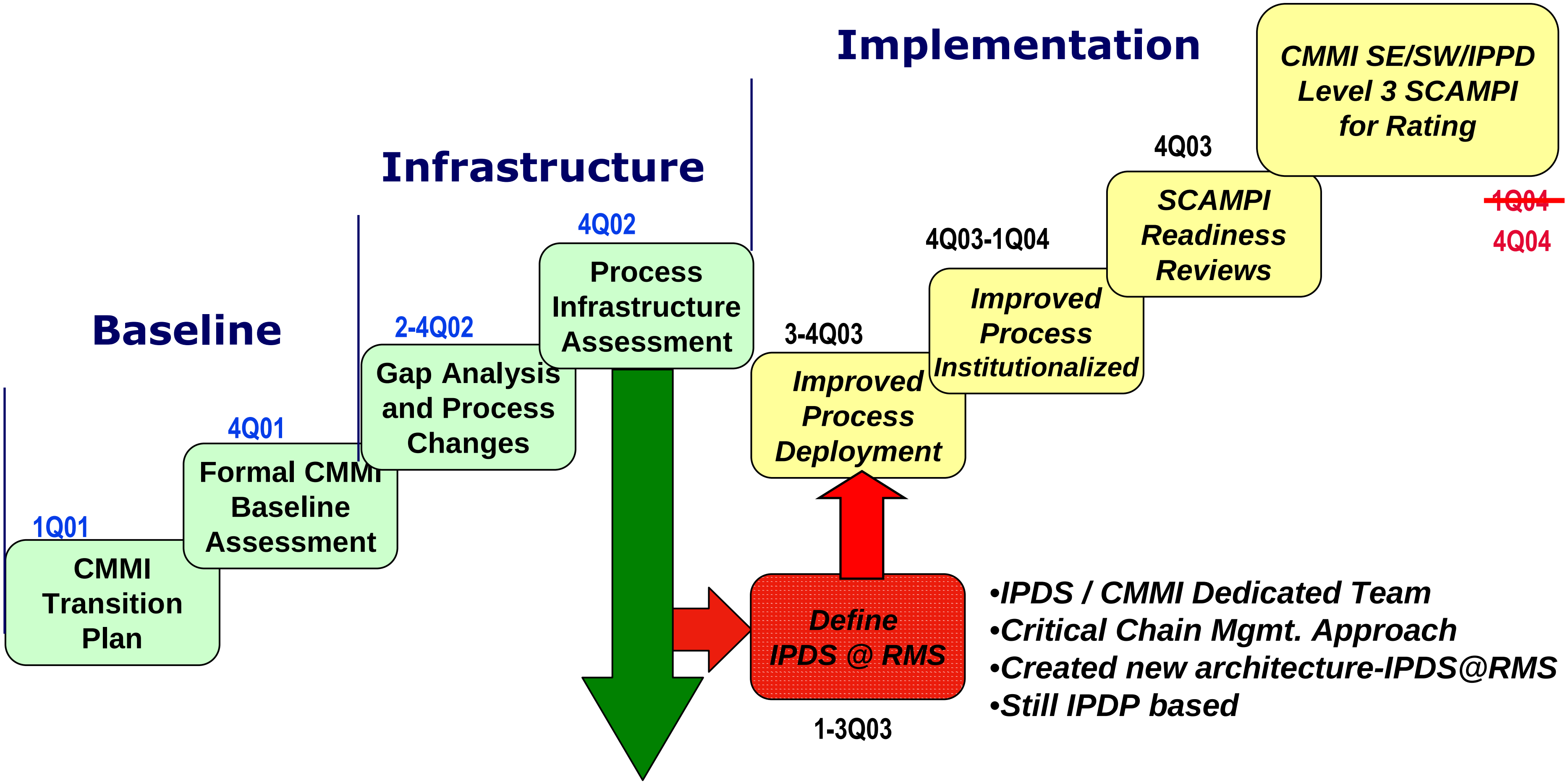
RMS Roadmap to CMMI Level 3



- *IPDS / CMMI Dedicated Team*
- *Critical Chain Mgmt. Approach*
- *Created new architecture-IPDS@RMS*
- *Still IPDP based*

The whole process takes time

CMMI Organization

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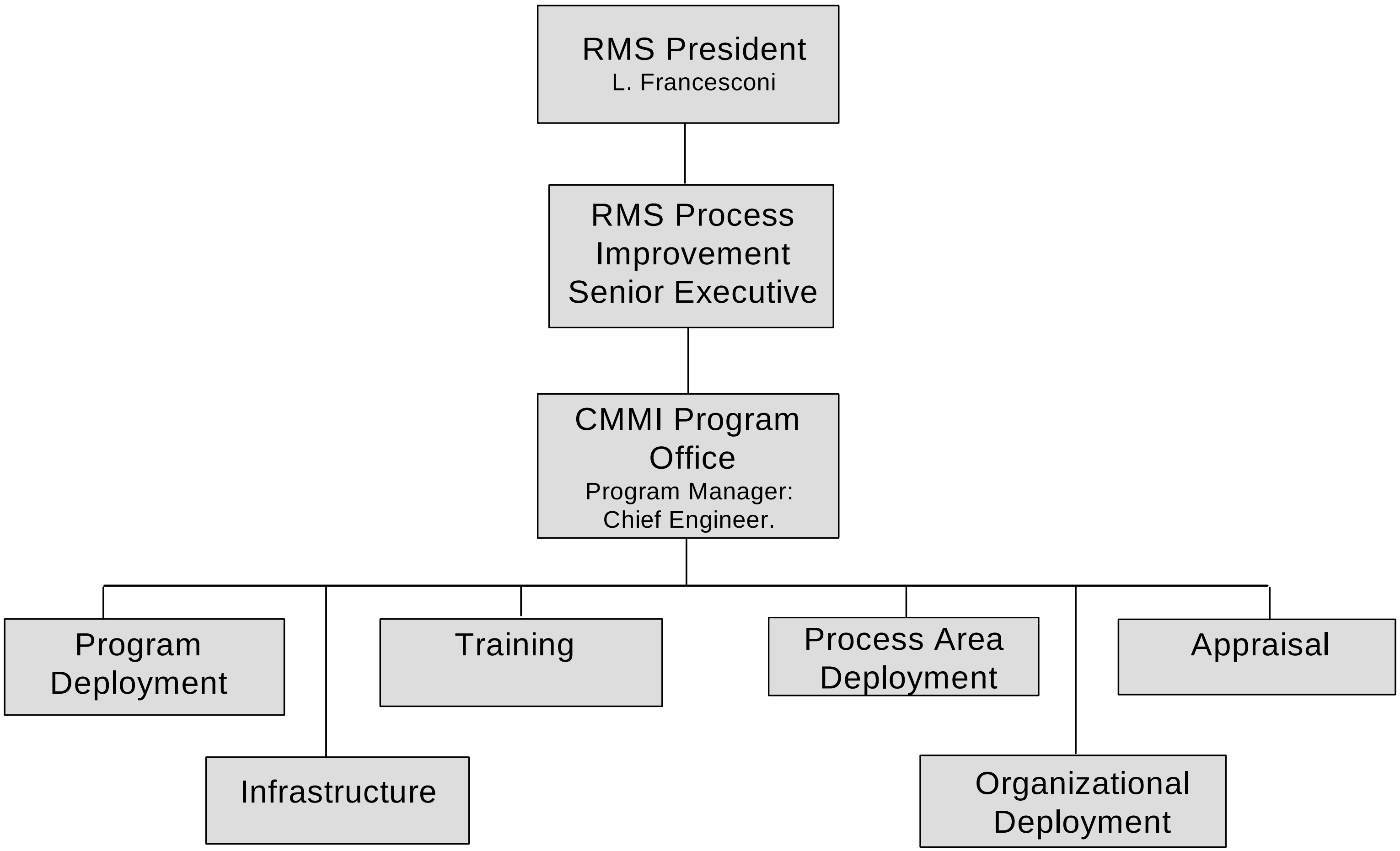

Program had a direct link to RMS President

CMMI Level 3 Master Schedule

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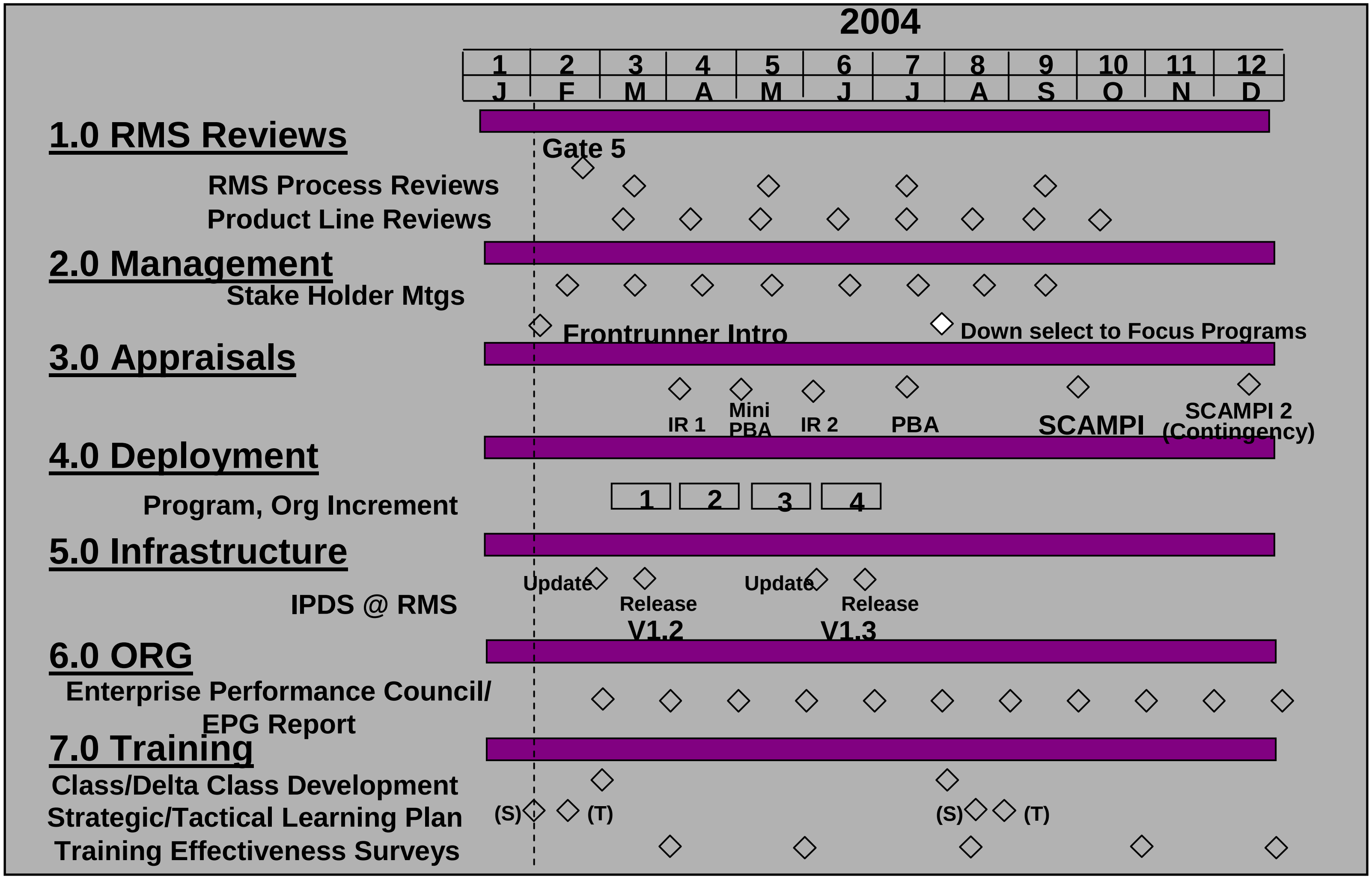
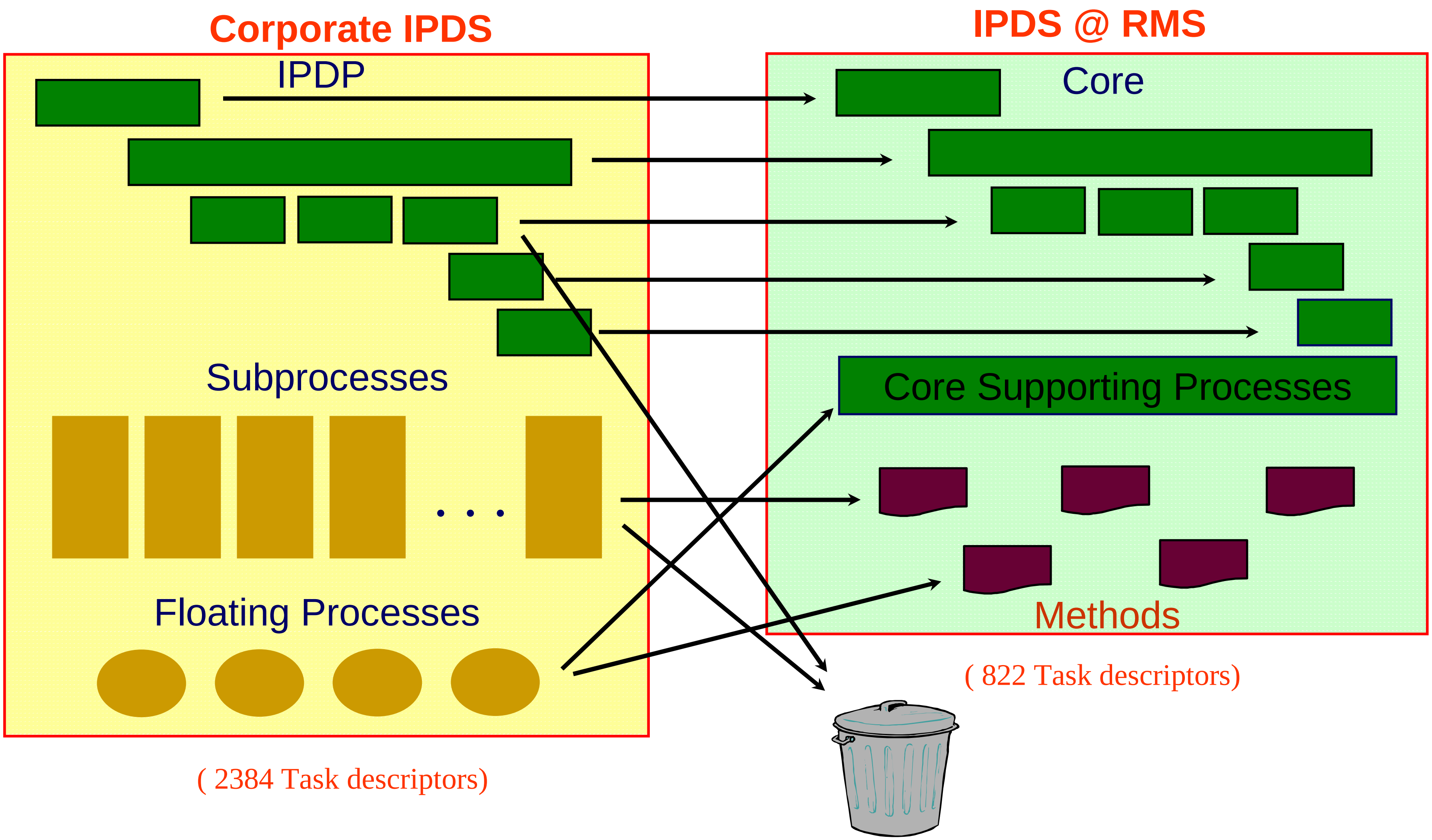


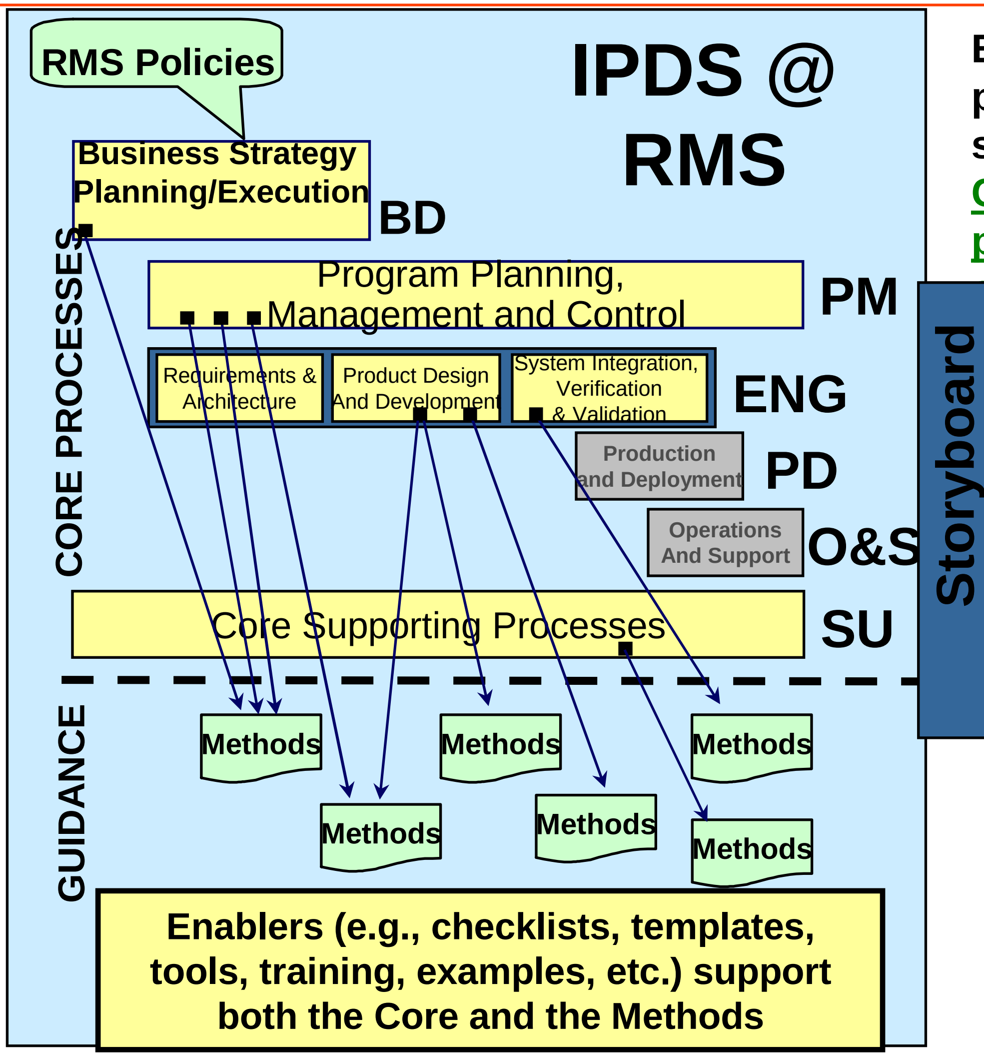
Simple schedule ?

Where did IPDS @ RMS come from?



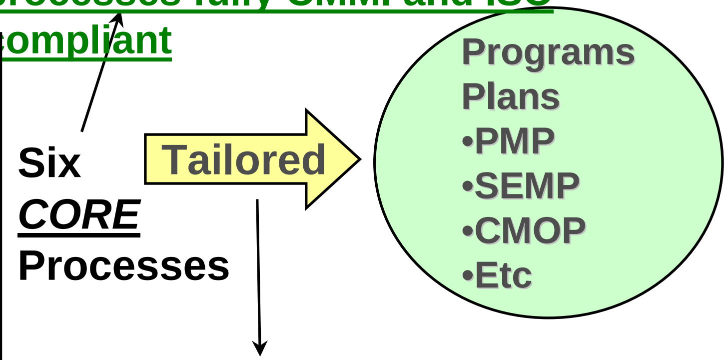
Our goal was to use everything we could from IPDS, but simplify it

IPDS @ RMS Architecture



Each ***CORE*** process represented by process flows, task descriptors, and storyboards.

Combination of the six Core processes fully CMMI and ISO compliant



What processes will be used, modified, or added. What products will be included. Selection of appropriate methods.

Simple architecture

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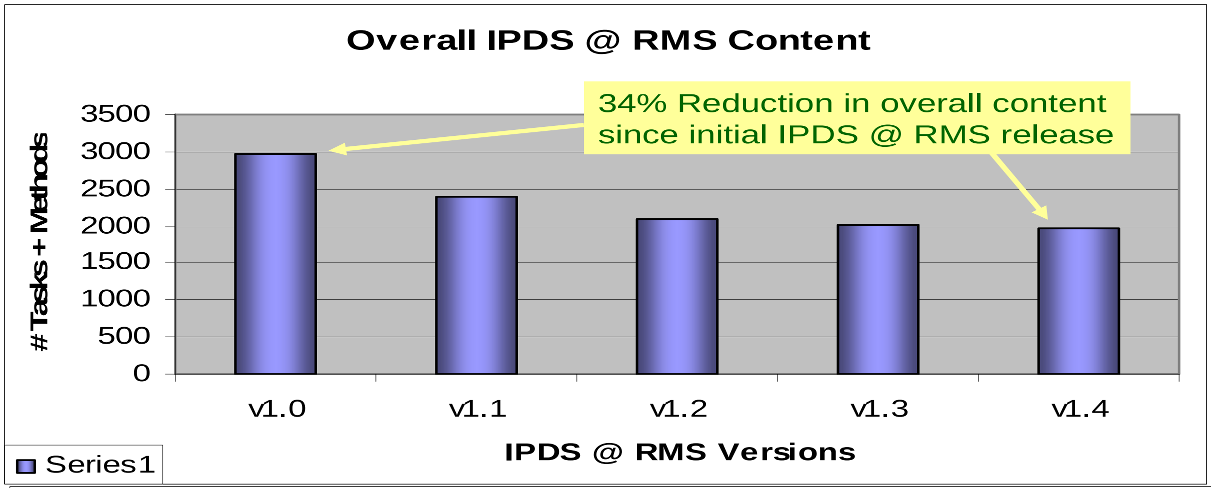
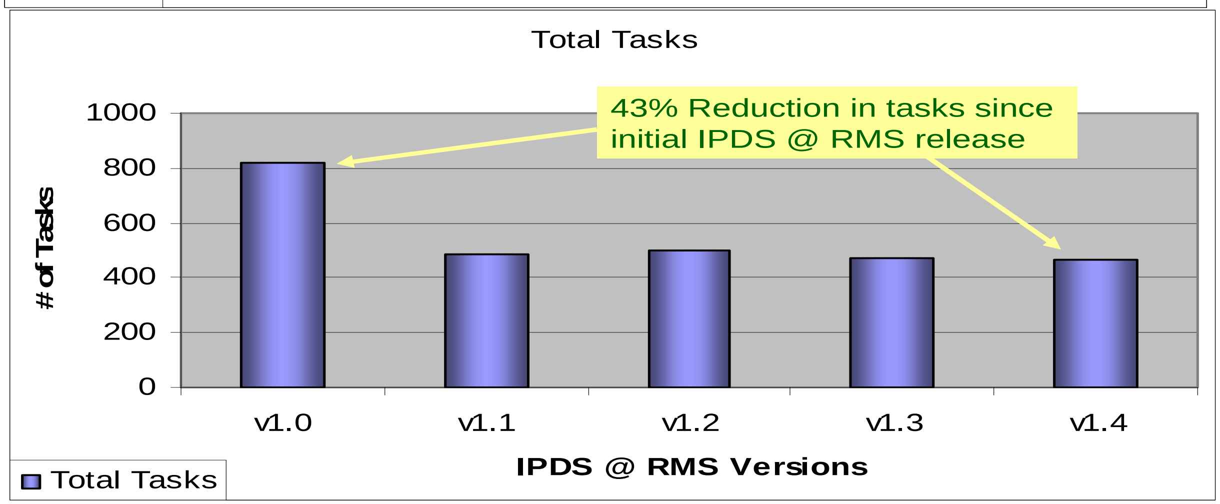
IPDS @ RMS Streamlining





Simplify it!

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Vetted Detailed Plan

- Plans placed across a 20 ft wide wall
  - Wall-walks addressed hot spots
  - Stickies used too allow easy details adjustment
- Brought most Stakeholders to a centralized location
  - Dedicated meeting rooms next to core team members
- Multiple events provided to engage Stakeholders
  - Daily Morning Stand-Ups with Core Team
  - Weekly Status Meetings with extended Core Team
  - Monthly Frontrunner lunches
  - Monthly Functional Leadership breakfasts
  - Quarterly Organizational Leadership reviews
  - IPDS@RMS Gate Reviews

Regularly scheduled meeting allowed for quick Communication and agreement on Plan modifications

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Value to Programs

- Engaging the Stakeholders increased buy-in
  - Frontrunner Programs instituted new processes, becoming more efficient in their performance execution
  - Functional Leadership committed to provided Subject-Matter-Experts well-versed on IPDS@RMS requirements
- Greater understanding of the intent of IPDS@RMS
  - Tailor processes to enhance performance
  - Document tailoring decisions
- More selective in opportunities to pursue
  - Recognize and walk away from unprofitable situations
- CMMI Level 3 Certification
  - Increased Customer confidence

↗ buy- in ⇨ ↗ understanding ⇨ ↗ success⇨ ↗ bookings ⇨ ↗ profitability

Results

- Utilized CMMI Appraisal Expertise to host numerous audits
  - **Findings and improvements rolled back into the process**
- Major improvements to the IPDS@RMS process content
  - **CMMI Level 3 requirements integrated**
- Greater awareness of IPDS@RMS capabilities
  - **Increased use across the Organization**
- Improvement in Subject-Matter-Experts
  - **Better understanding by Process Owners**
- Training & Implementation processes improved
  - **Offerings better tailored to meet Program needs**
- Improved coordination between Process experts
  - **Integrated Program Start Up Team**
- 2 Frontrunner Programs awarded additional contracts

"If you build it, they will come" *Field of Dreams*

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Key elements of our approach

Attained GOAL:
CMMI Level 3 Certification
December 2004

Largest world wide facility to obtain CMMI Level 3 Certification

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Customer Success Is Our Mission

Quality Assurance Involvement Compared to Program Results

Jill A. Brooks
Network Centric Systems

Agenda

- Introduction
- Software Engineering Institute Insight
- Raytheon North Texas Data
  - Cost Performance
  - Schedule Performance
  - Quality
- Lessons Learned
- Other Considerations
- Next Steps

Quality Assurance Involvement
Compared to Program Results

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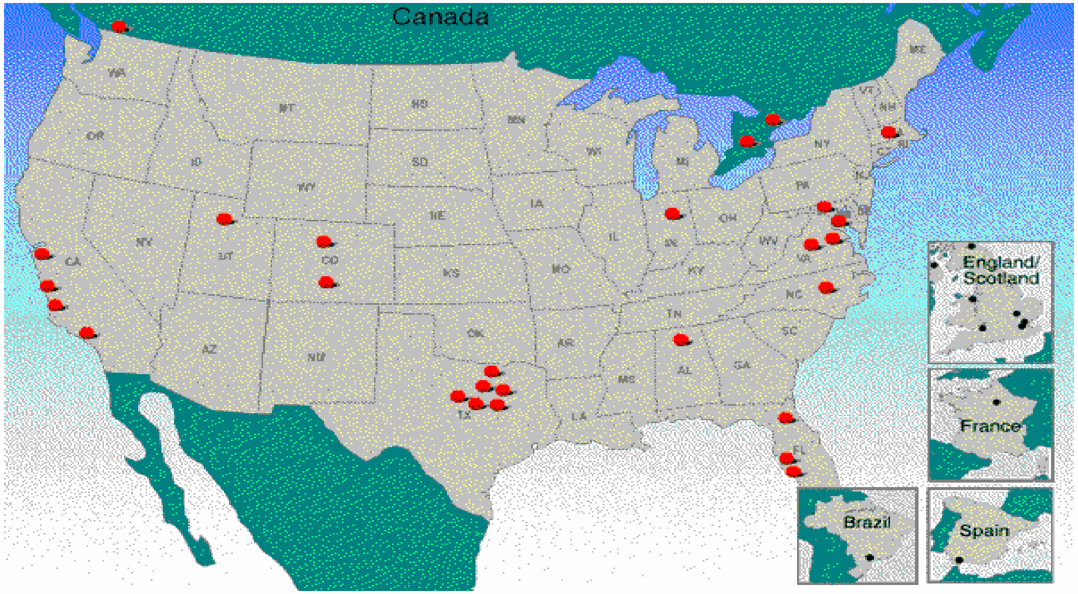
Introduction - Raytheon

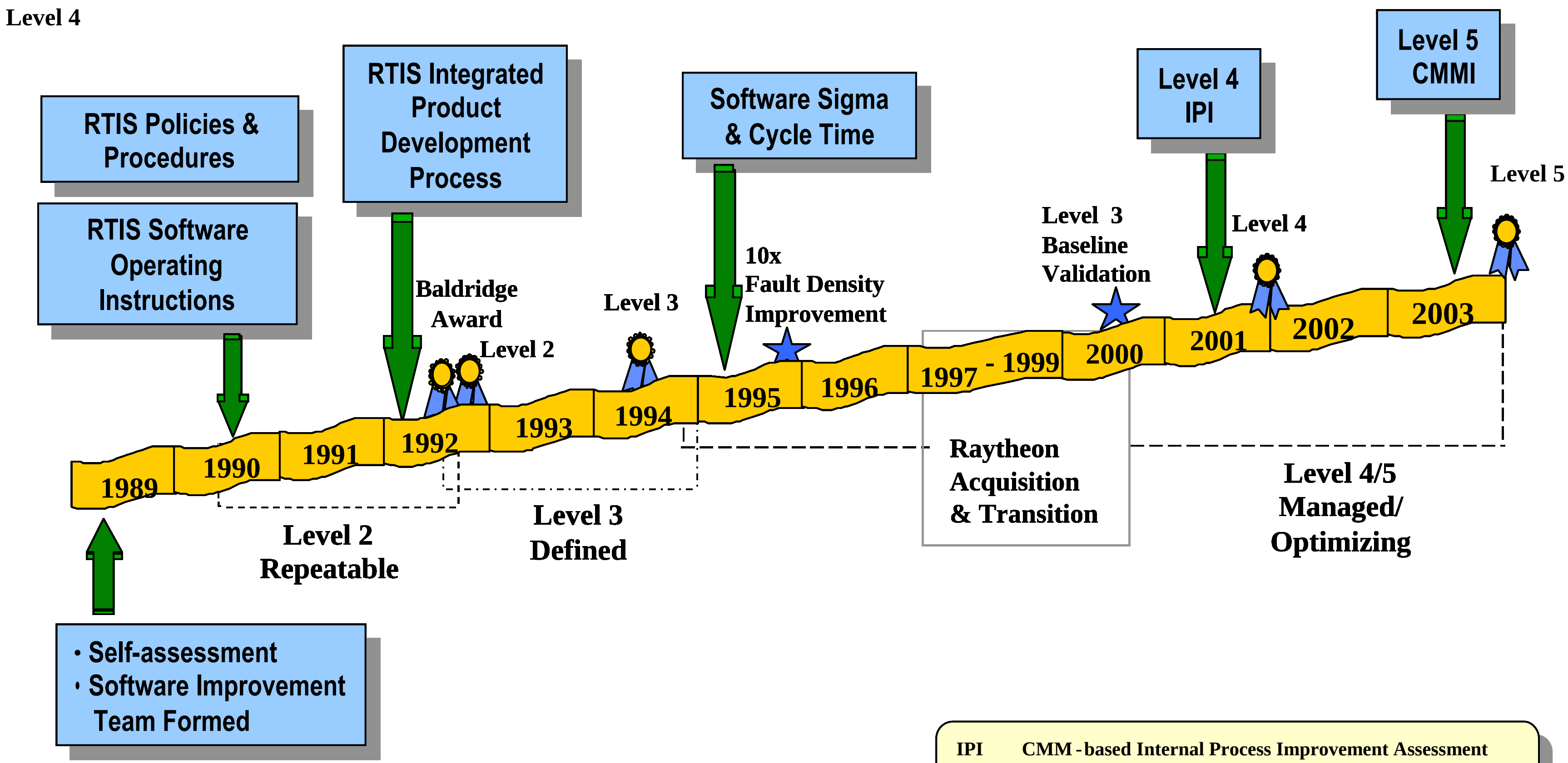
- Raytheon is an industry leader in defense and government electronics, space, information technology, technical services, and business aviation and special mission aircraft
- Network Centric Systems (NCS) develops and produces mission solutions for networking, command and control, battlespace awareness, and air traffic management
- Space and Airborne Systems (SAS) provides electro-optic/infrared sensors, airborne radars, solid state high energy lasers, precision guidance systems, electronic warfare systems, and space-qualified systems for civil and military applications
- Raytheon-specific data examined for this presentation draws on both NCS and SAS programs executed in North Texas. Data is from software programs

Introduction – Raytheon continued

- For NCS North Texas:
  - 8 QE engineers
  - 145 Software Engineers
  - 30 Programs (including maintenance efforts)



Introduction – Raytheon continued



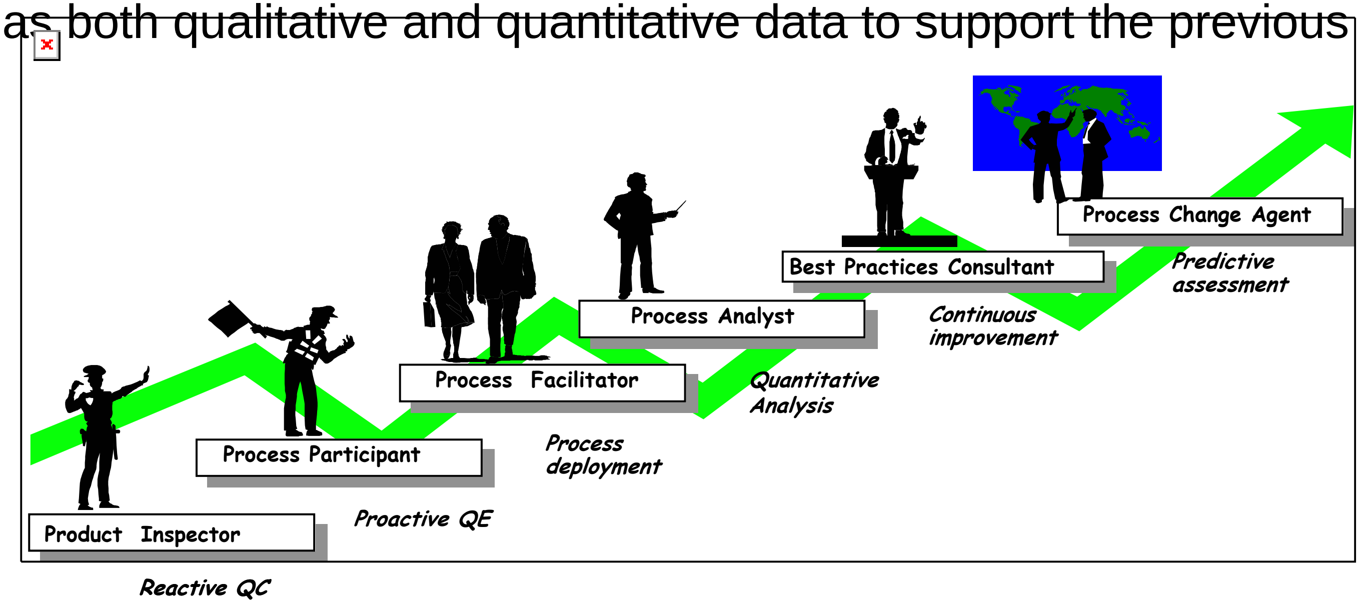
IPI	CMM-based Internal Process Improvement Assessment
RTIS	Raytheon/TI Systems
CMMI	CMM Integrated

Introduction – The Burning Platform

- Although the CMMI introduces Quality Assurance (QA) at Level 2, and QA is further expanded at higher levels of maturity, QA functions still have to “prove” their worth as QA is often viewed as an “overhead” function

Software Engineering Institute (SEI) Insight

- Quality Assurance is introduced at Level 2 of the Capability Maturity Model Integrated (CMMI)
- Quality activities are in all process areas
- As organizations move up the maturity ladder, there are improvements in program performance
- SEI has both qualitative and quantitative data to support the previous statement



The SEI has collected data which illustrates the correlation between organizational maturity and improved performance

SEI Insight

- Performance results summarized by the Software Engineering Institute, March 4, 2005

Performance Improvement Category	Low	Median	High	Number of Data Points
Cost	4.5%	38%	87%	14
Schedule	20%	50%	90%	14
Productivity	11%	50%	376%	13
Quality	29%	50%	94%	16
Customer Satisfaction	10%	14%	55%	5
Return on Investment	2 : 1	3 : 1	13 : 1	8

Reference: http://www.sei.cmu.edu/cmmi/results.html

Raytheon North Texas Data – Cost Performance

- QE Involvement is measured as a percentage of the total effort on the program
- Cost Performance Index (CPI) is measured as the ratio of the Budgeted Cost of Work Performed (BCWP) to the Actual Cost of Work Performed (ACWP)

$$\text{CPI} = \frac{\text{BCWP}}{\text{ACWP}}$$

Raytheon North Texas Data – Cost Performance

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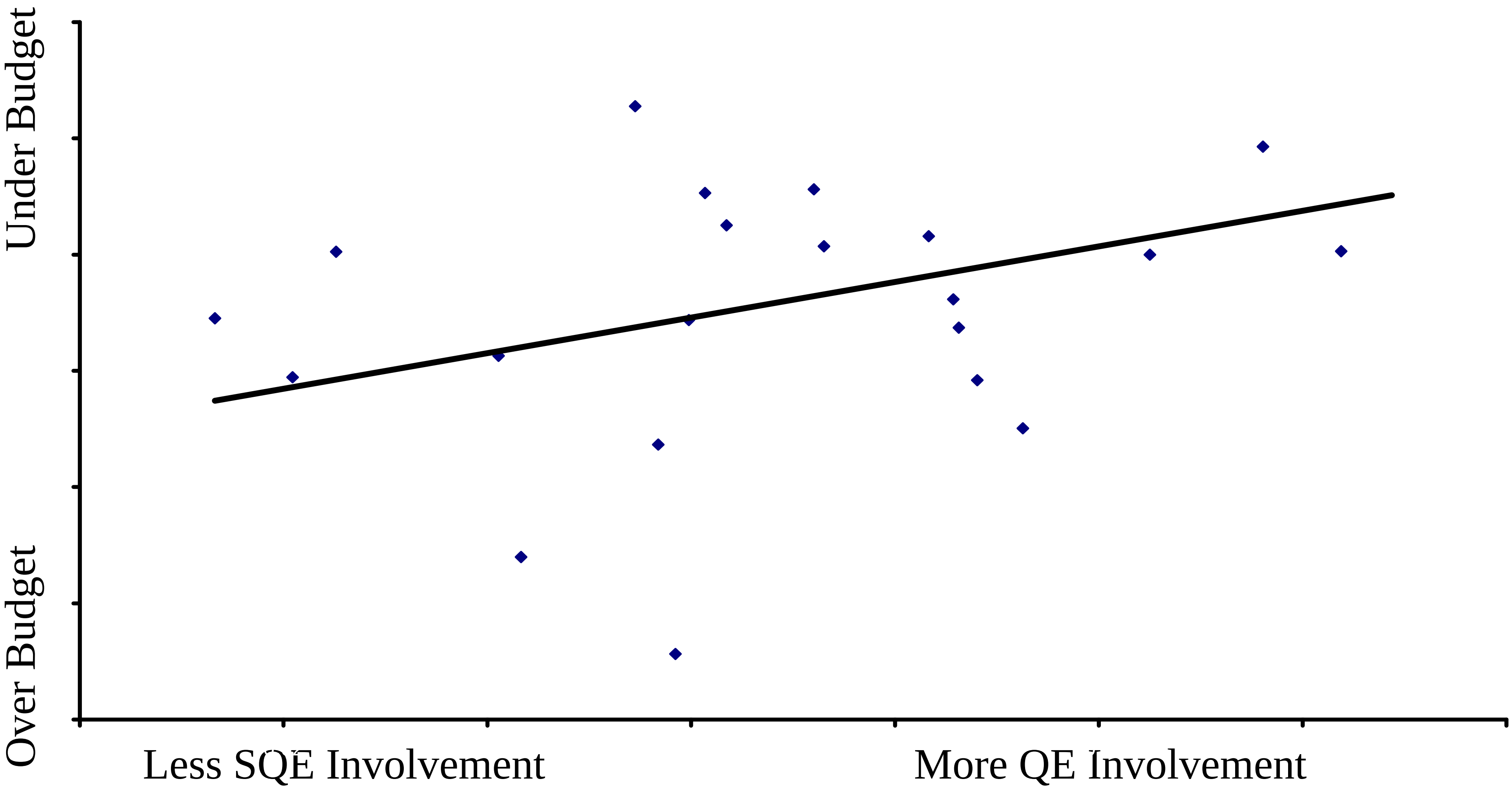

There is a positive correlation between QE Involvement and Program Cost (measured via CPI)

Raytheon North Texas Data – Schedule Performance

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- QE Involvement is measured as a percentage of the total effort on the program

- Schedule Performance Index (SPI) is measured as the ratio of the Budgeted Cost of Work Scheduled (BCWS) to the Actual Cost of Work Performed (ACWP)

$$SPI = \frac{BCWS}{ACWP}$$

Raytheon North Texas Data – Schedule Performance

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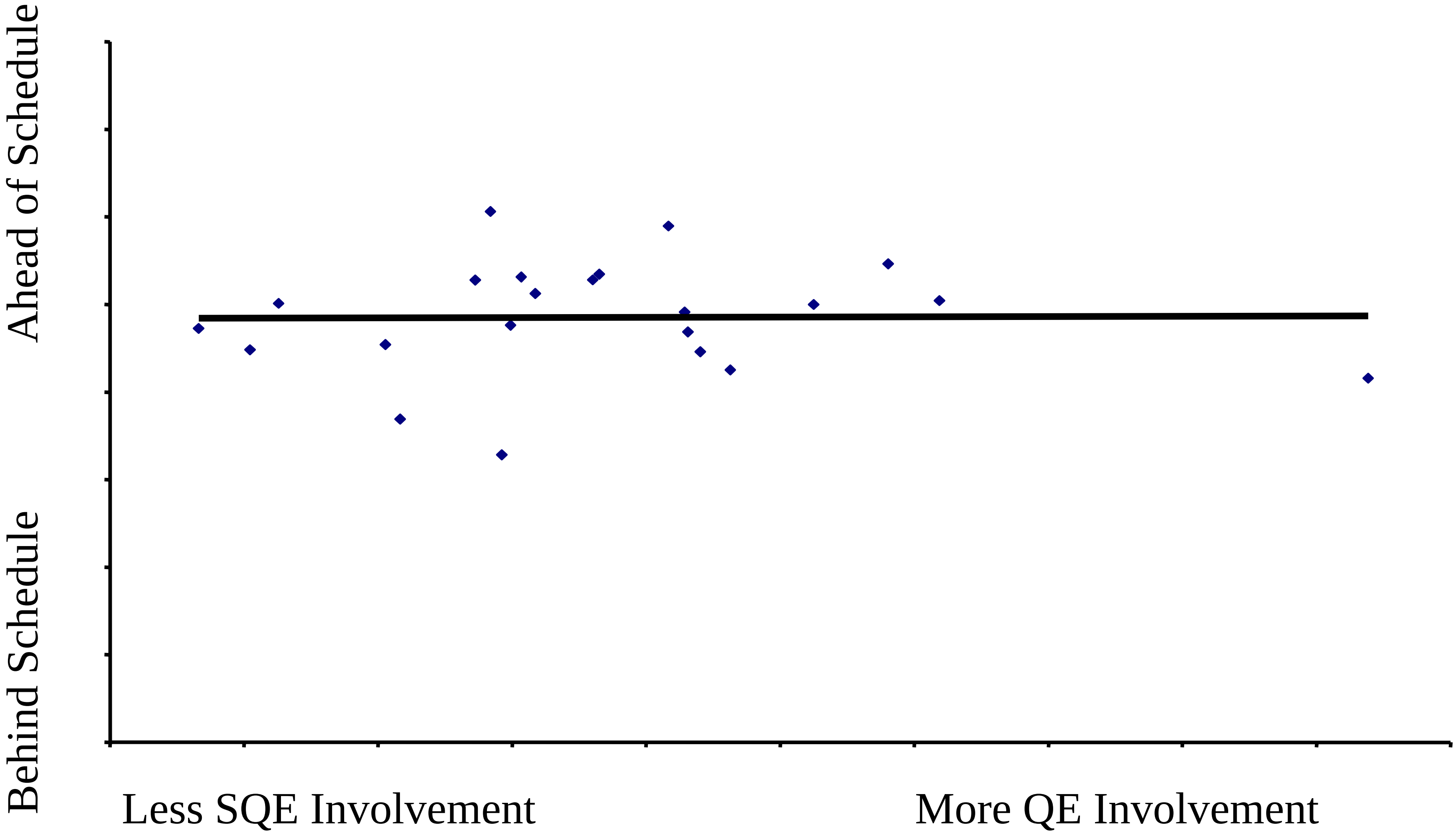

No apparent correlation between QE Involvement and Program Schedule (via SPI)

Raytheon North Texas Data – Quality Defect Containment

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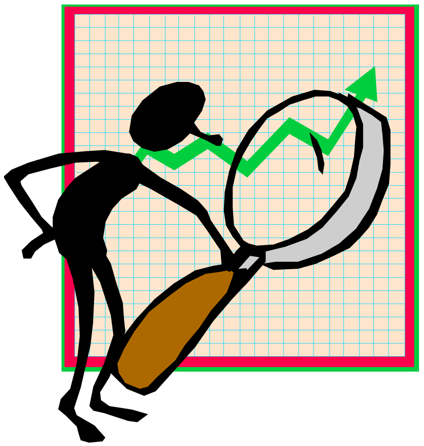
- QE Involvement is measured as a percentage of the total effort on the program

- Defect Containment (DC) is measured as the ratio of the number of defects which were detected “in phase” versus the total number of defects

$$DC = \frac{\text{In-phase Defects}}{\text{Total Number of Defects}}$$



Raytheon North Texas Data – Quality Defect Containment

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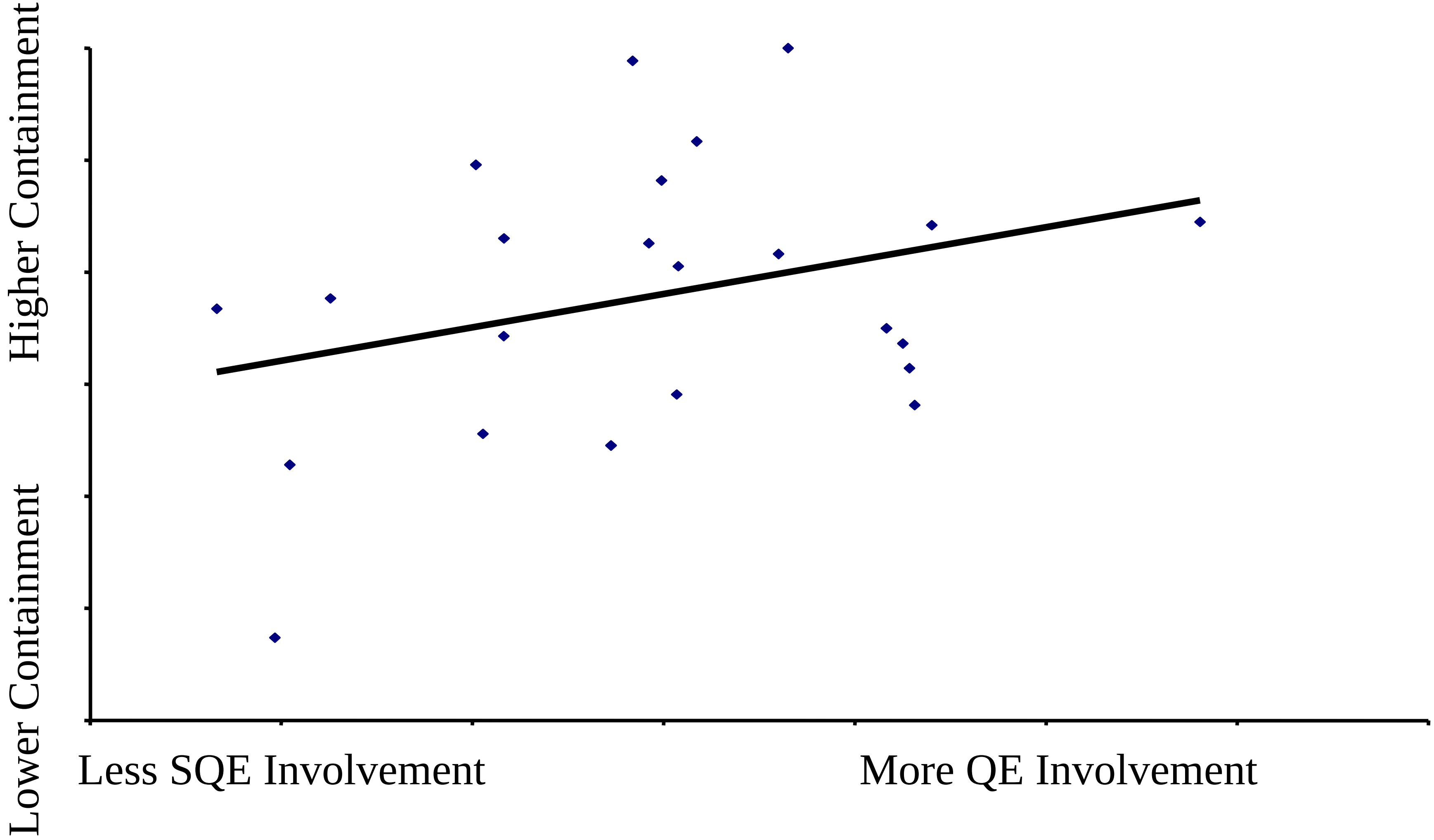
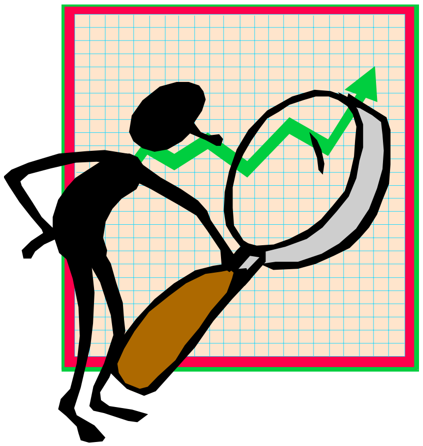


There is a positive correlation between QE involvement and Defect Containment

Raytheon North Texas Data – Quality Defect Density

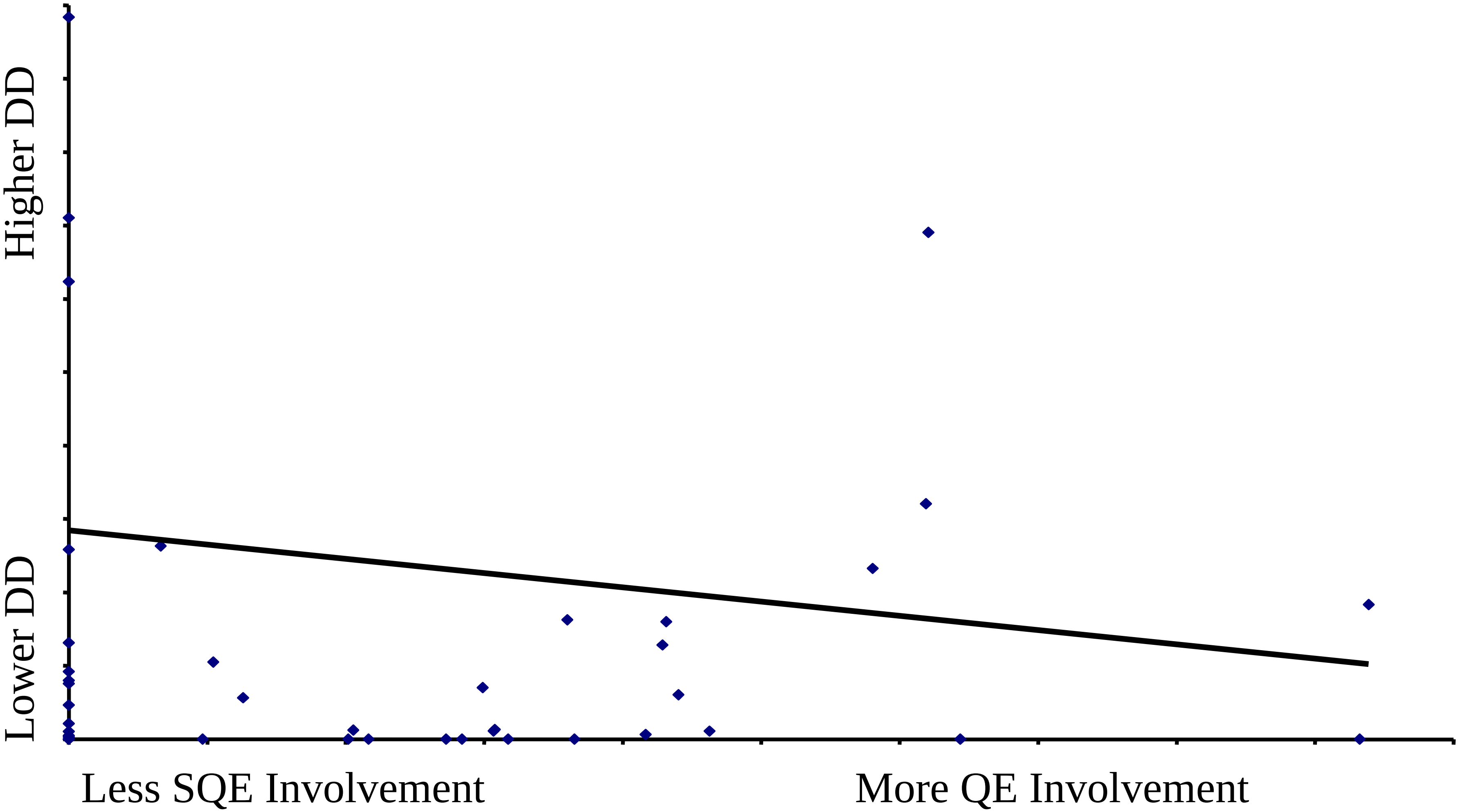
- QE Involvement is measured as a percentage of the total effort on the program
- Defect Density (DD) is measured as the ratio of the number of defects which were detected post delivery versus the size of the product. Note the Equivalent Lines of Code was used to adjust for programs with significant amounts of legacy code

$$DD = \frac{\text{Post Delivery Defects}}{\text{Equivalent Lines of Code}}$$



Raytheon North Texas Data – Quality Defect Density (DD)

Raytheon



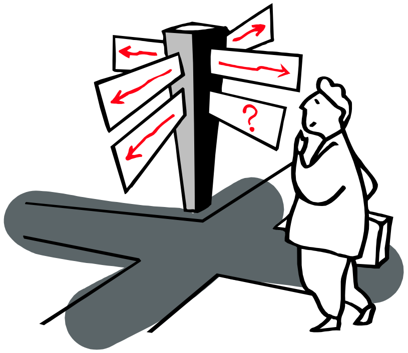
There is a negative correlation between QE involvement and Defect Density, which is a good thing!

Lessons Learned

- Data, data, data
  - Multiple data repositories
  - The color of money
    - ❑ Level of granularity: QE sometimes counted as part of management, planning and control
    - ❑ QE may perform expanded role activities (non-traditional QE activities) which are sometimes counted in the QE “bucket”

Other Considerations

- Execution of QE improved (QE productivity/efficiency)
  - Don’t currently have a formal metric for this
  - Process has matured
  - QE staff has had very little attrition
  - Getting more “bang” for the QE buck?



QE productivity / efficiency is an opportunity for future analysis

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Other Considerations

- Customer value of QE involvement
  - Don't currently have a formal metric for this (have customer satisfaction scorecards, but it is not clear if these have the level of granularity required to examine customer perceived value of QE activities)
  - QE involvement required by some contracts
  - QE often has established long-standing relationships with customers
  - Customers request QE participation in various activities

Customer Value of QE Involvement is another relationship to examine

Next Steps

- Continuous Improvement continues…
  - Data repository consolidation
  - NCS is moving towards standardized cost collection system with increased granularity
  - Metrics are being standardized across disciplines: Systems Engineering, Software Engineering, and Hardware Engineering

Although there is evidence that increased QE involvement has a positive impact on program success, there are opportunities for improvement of the data and more analysis in the future!

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Questions

Raytheon
Customer Success Is Our Mission

Applying CMMI to Services

Gordon Ward Director Of Quality & R6s™ Raytheon RIS
Juan Ceva, Mark Pumar, Enterprise Process Group Raytheon

Agenda

- Background
- Lessons Learned
- History
- Epiphanies
- Approach
- Conclusion

"…he who attempts it must first pass the point of this lance;" and so saying he brandished it so stoutly and dexterously that he overawed all who did not know him.

Miguel de Cervantes
Don Quixote

Background – Critical Issues

- *Need to be CMMI (L3) to stay in Business.*
- *Service Organization (that don't fit into the traditional product development model) struggle to achieve CMMI L3 in a timely and cost effective manner.*
- *How does an organization staffed with practitioners from standard (product oriented) high maturity organizations, with large range in its technical disciplines, little or no process dollars, and little or no project autonomy achieve a CMMI level 3?*
- *Welcome to the World of Technical Services!*

Raytheon

Background – Pasadena Operations

- Raytheon's Pasadena Operations
  - Part of Raytheon Information Solutions.
  - Establish in 1998 with the award of the SDSIO (Science Data System Implementation and Operations) contract by the California Institute of Technology and NASA's Jet Propulsion Laboratory (JPL).
  - Umbrella services contract allowing JPL Managers to contract directly with Raytheon for technical and scientific services.
  - Consists of functional departments organized along lines of businesses reporting to a Program Manager.
  - Technical disciplines range from software and systems engineering to IT, scientific analysis, and web development.

Background – Challenges to CMMI

- Service, not product-based organization.
  - No traditional end-to-end lifecycle.
  - Customer directing work – little or no autonomy.
  - Small overhead – no funding for process support & development.
- Blurring of function within projects and across departments.
  - Project activities range from software development to graphic design.
  - Departments support operations, IT, analysis, and development.
- Raytheon and Customer culture significantly different.
  - Research versus product oriented.
  - Low process maturity (relative to industry).
  - Small teams (1-2 FTE) with modest funding.

Process Improvement History

- Grass root effort
  - Started with (unfunded) special interest group in March 1999.
  - Prevailing feeling that Customer would be better served if proven process could be applied to each task.
  - Most members worked for high maturity organizations before coming to Pasadena.
- False starts and dead ends 1998 – 2003
  - Top-down approach to process improvement (unsuccessful)
  - Obstacles:
    - CMM, no CMMI yet
    - Lack of process infrastructure (QA, CM, MA, etc.)
    - Customer “owns” project areas (PP, PMC, IPM, Risk)
    - Small, diverse, short-term (< year) projects
    - Customer chooses not to perform some key practices
    - Funding

Process Improvement History (cont.)

- Alternatives
  - ***Approach*:** Restrict process to one or two projects where sufficient autonomy existed to apply Model.
  - **Drawbacks:** *No benefit on most projects; limited benefit to customer.*

  - ***Approach*:** Apply Model to a collective group of projects, with no single project performing all key practices of the Model.
  - **Drawbacks:** *Risky – might loose one or more key projects.*

  - ***Approach*:** Completely new (non-traditional) approach.
  - **Drawbacks:** *Not clear how to proceed; requires 'breakthroughs'.*

History (cont.)

- Breakthroughs 2003 and 2004

  – Use bottom-up approach.
    - Develop lifecycle based on how work is actually done.
    - Map Model to lifecycle.
    - “Fill” process gaps.

  – Shift focus to delivery of <u>*service*</u> instead of delivery of a product.

  – Use Raytheon Six-Sigma for process improvement.

  – Use a traditional engineering lifecycle (requirements, design, implementation, verification and validation) to develop the process.

  – Employ an evolutionary or staged approach to implementation.

Raytheon

Epiphanies

- Key breakthroughs that resulted in substantial progress in applying the CMMI to services.

- Epiphany 1: *Task Orders are equivalent to projects*.
  - Apply process to every task order.
  - Re-identify each Model key practice with an equivalent practices in the service environment.

- Epiphany 2: *Project requirements are services requested by the Customer*.
  - Requirements are the Customer requests for services in the form of personnel and attendant support.

Raytheon

Epiphanies (cont.)

- Epiphany 3: *Every project has the same (unchanging) five requirements.*
  - Requirements are:
    - **Staffing** – e.g. supply two oceanographers.
    - **Facilities** – e.g. provide office space and equipment for assigned personnel.
    - **Finance**s – e.g. monitor and report cost associated with supplying 2 oceanographers.
    - **Management** – e.g. manage the task order (find staff and facilities, monitor cost and personnel).
    - **Infrastructure Support** – e.g. provide networks, phones, computers, etc. for 2 oceanographers.

Epiphanies (cont.)

- Epiphany 4: *The relative time spent for development versus delivery in services is reversed from that of products*.
  - Products: most of the effort is spent ***developing*** the product.
  - Services: most of the effort is spent ***delivering*** the service.

Approach

- ***Template-based solutions.***
  - Technical staff and management not burdened with process details that are not directly applicable to their work.
  - Technical staff works with solutions that are relevant to their everyday tasks without having to become versed in the CMMI.
  - A relatively small group of Model experts can concentrate on insuring that the CMMI practice areas are covered via the usage of the templates.

Enterprise Best Practices

best@sdsio.jpl.nasa.gov

Statement of Work

Process Fact Sheet

July 21, 2004

Purpose/Use:

- Who Cares?
  - JPL CWO Manager
  - Ray CWO Manager
  - Ray Leads
  - Ray Dept. Manager
  - Ray Program Manager
- The SOW is generated by the customer at the start of a new contract or whenever a change in scope to the project occurs.
- In many cases, the SOW is generated with input from Raytheon.
- The template is used whenever the JPL CWO Manager requests input from Raytheon in generating the SOW.

Tips:

- The Statement of Work is a JPL document and should be developed in concert with JPL CWO Manager.
- The Template and example document are available in the Process Asset Library (PAL).
- Keep the SOW up to date with the customer during the life of the project.

Learn More:

The Process Asset Library (PAL) has links to process, procedures, documents, templates and more.

EPG Open House	**SOW Training Slides**	**Process SIG Meeting**
Every Monday	PAL	7/22/2004
11-12pm		8/26/2004
Tech Exchange Room		Main Conference Room

Enterprise Best Practices

best@sdsio.jpl.nasa.gov

Meeting Minutes

Process Fact Sheet

July 21, 2004

Purpose/Use:

- Who Cares?
  - All Staff
  - JPL Customers
- The Meeting Minutes template is used to record discussion and action items during all meetings.
- Meeting Minutes are shared with all invited attendees and archived in a common area for the group to access and refer back to.

Tips:

- Fill out the top part of the template completely (subject, date, participants, etc.)
- Prevent tedious and time consuming note taking by capturing only the main points of discussion and the action items.

Learn More:

The Process Asset Library (PAL) has links to process, procedures, documents, templates and more.

EPG Open House	**Meeting Minutes Template**	**Process SIG Meeting**
Every Monday	PAL	7/22/2004
11-12pm		8/26/2004
Tech Exchange Room		Main Conference Room

Approach (cont.)

Approach Used

- Multi-part SCAMPI C and B.
  - SCAMPI C divided into two events.
    - 1st event examined organization's business model.
    - 2nd event examined templates.
  - SCAMPI B divided into three events.
    - 1st event examined evidence from the project area of the Model on a single focus project.
    - 2nd event examined evidence from the support area of the Model.
    - 3rd event examined evidence from the engineering area of the Model.
  - Engaged appraisal team in improvement process
    - Team recommendations, solutions, and feedback incorporated into process before deployment.
  - SCAMPI A: Traditional

Traditional Approach

- C and B SCAMPIs are conducted as single events
  - SCAMPI C reviews policies & procedures
  - SCAMPI B reviews polices, procedures and artifacts

Lessons Learned

- ***Use Bottoms-up Approach***
  - Develop process solutions based on business model
  - Tailor solutions to the organization
- ***Run the implementation as a (serious) project.***
  - Establish a project manager, budget, schedule, and measurable goals.
  - Track and monitor progress on a regular basis using EVMS.
  - Use phased deployment
  - Develop and validate processes before deployment.
- ***Implement a 'grass roots' communications plan throughout the project***.
  - Start communication with staff and management early to establish and clarify goals.
  - Celebrate small successes publicly at all-hands meetings and other group events.
  - Setup recurring open houses and training sessions with the process developers.
  - Demonstrate the benefits to individuals.

Lessons Learned (cont.)

- ***Obtain stakeholders' support and active involvement***.
  - Gain sponsors at the highest level and understand their goals.
  - Involve Customers frequently via EPG and Steering Committee meetings.
  - Communicate the benefit of reaching goals.
- ***Make use of consultants***.
  - Leverage Model expertise from other parts of the organization.
  - Choose the lead appraiser wisely i.e. 'out-of-box' thinker.
  - Put the appraisal team to work for the organization.
  - Use their feedback to refine processes before deployment.

Conclusions

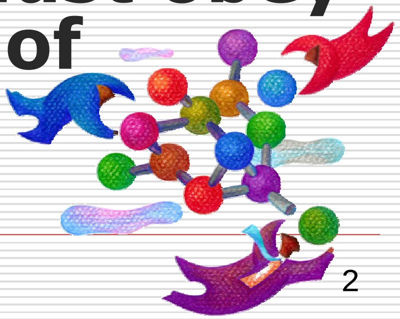
- Successfully implemented one of the first applications of the CMMI Model to Services
  - Technical Details Documented in (up-coming) SEI Technical Note
  - https://bscw.sei.cmu.edu/pub/bscw.cgi/0/79783
- Developed pragmatic and cost effective model to deploy CMMI in non-traditional applications
- True Process Improvement
  - Added processes meaningful and useful to organization
    - Day-to-day operations improved
    - Organization more efficient and effective at delivering services
  - Increased engagement with customer at all levels

CMMI AS A SAFEGAURD AGAINST SOFTWARE ENTROPY: MANAGER'S PERSPECTIVE

Dr. Thomas F. Christian Jr.
Director of Engineering
ACSSW, WPAFB OH
16 Nov, 2005

SOFTWARE ENGINEERING

- Software Engineering is part of Systems Engineering
- Systems Engineering is the disciplined application of tools and principles to achieve a complex goal
- Systems Engineering must obey the Fundamental Laws of Physics



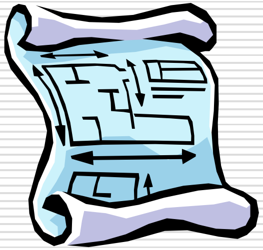
THE LAWS OF PHYSICS

- But what are the fundamental laws of physics?

- F=MA?
- Earlier seminal work at SSTC 2005 said “Yes” – Newton’s Laws of Motion govern Software Engineering

THE LAWS OF METAPHYSICS

- "I think therefore I code"
- No, No!!
- Even EEs understand Inertia but, could there be some law even more fundamental than that?



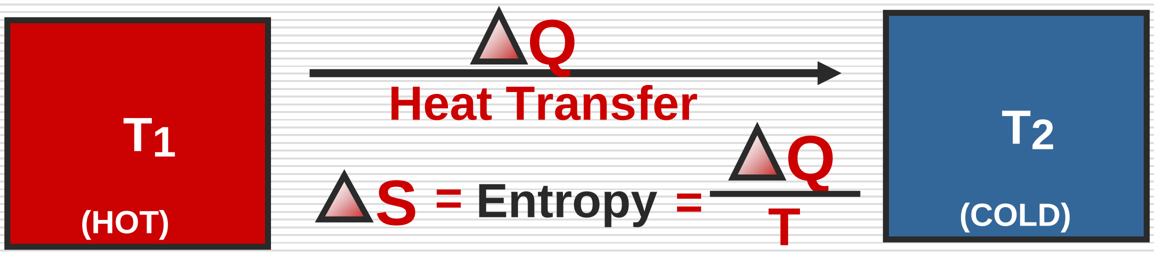
THE LAWS OF NATURAL PHILOSOPHY

-- YES --

THERMO

The unexplainable

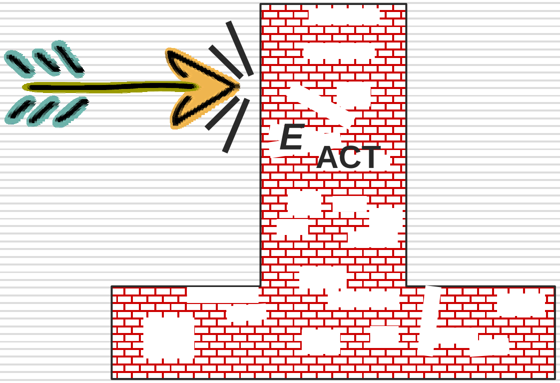
1^{ST} LAW – CONSERVATION OF ENERGY



"If the state of a system is changed by applying work or heat or both, then the change in the energy of the system must equal the energy applied"

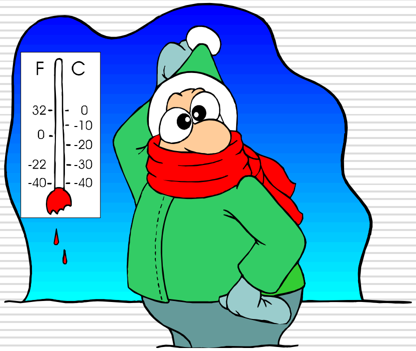
2nd LAW – TENDENCY TOWARD EQUILIBRIUM

"It is impossible to move heat, by cyclical process from something at lower temperature to something at higher temperature unless work is added to the system"



3rd LAW – ABSOLUTE ZERO

"If the entropy of each element at absolute zero can be taken as zero, then all elements above absolute zero must have a finite, positive entropy; however, because entropy cannot be reduced to zero by finite means (as per the Second Law), no system can reach absolute zero"



Since we are Software Engineers - Not Physicists –

Let's put them into Software Engineering - Speak

- 1st Law: You Can't Win – Just Break Even
- 2nd Law: You Can Only Break Even at Absolute Zero
- 3rd Law: You Can't Reach Absolute Zero

THE SOFTWARE LAWS OF THERMODYNAMICS

- Optimizing software quality, cost, schedule require proper processes, planning, and people
- Proper processes, planning and people requires time to do it right
- There is NEVER time to do it right

“RASSA’S LAW”

- “No one can resist the temptation to edit another’s work or start coding on the first day of a program”

NDIA CMMI Technology
Conference & User Group

Denver, CO

A Change Agent in a Level 1 Organization:

How to Survive in a Hostile Environment

CMMI

ASPI ABB SOFTWARE PROCESS INITIATIVE

ABB

Agenda

- Introduction
- L1 Organization = Hostile Environment?
- Understanding Resistance
- Challenges to Change in L1 Organization
- How to be a Change Agent in a L1 Organization
- Creative Ways of Measuring/Advertising Success
- Summary

ABB

- Leader in power and automation technologies
- Enable utility and industry customers to improve performance while lowering environmental impact
- The ABB Group of companies operates in more than 120 countries and employs approximately 120,000 people
- ABB became the first company in the world to sell 100,000 robots
- A vast majority of products at ABB have software and hardware components

ABB's Organizational Structure

- Power Technologies
  - Power Systems
  - Medium-Voltage Products
  - High Voltage Products
  - Transformers
  - Utility Automation Systems
- Automation Technologies
  - Automation Products
  - Manufacturing Automation
  - Process Automation

ABB

- ABB Software Process Initiative (ASPI)
- ASPI is composed of members from 2 ABB Corporate Research Centers (CRCs):
  - United States: Raleigh
  - Sweden: Vasteras
- Responsible for: Development of appraisal and improvement methodologies, evaluation and deployment of pilots within ABB for CMMI transition, PSP/TSP, etc.

L1 Organization = Hostile Environment? - 1

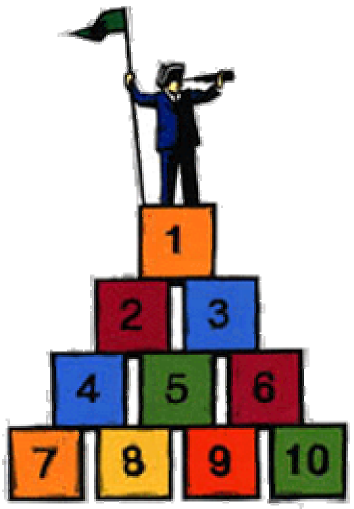
- Why might a level 1 organization be considered a Hostile Environment?
  - L1 Organizations don’t plan or monitor well
    - Firefighting is the norm – TENSION!
    - No time for instituting change

L1 Organization = Hostile Environment? - 2

- Why might a level 1 organization be considered a Hostile Environment?
  - Heroes are key to success
    - The change may be seen as a threat

L1 Organization = Hostile Environment? - 3

- Why might a level 1 organization be considered a Hostile Environment?
  - Middle managers – Top-10 or none
    - Changes/improvement efforts typically don't make the top-10 list



Managing Resistance - 1

Why People Resist

- Maintain Status Quo and avoid transition state
- Protect individual and organizational
  - Values
  - Emotions
  - Ways of operating

When Does Resistance Increase?

- Low perceived need
- Implies poor past performance
- High level of disruption
- Low reward / high cost
- Negative consequences
- Irreversible outcome
- Doubt about success
- Fear of unknown
- Unclear expectations
- and Low involvement

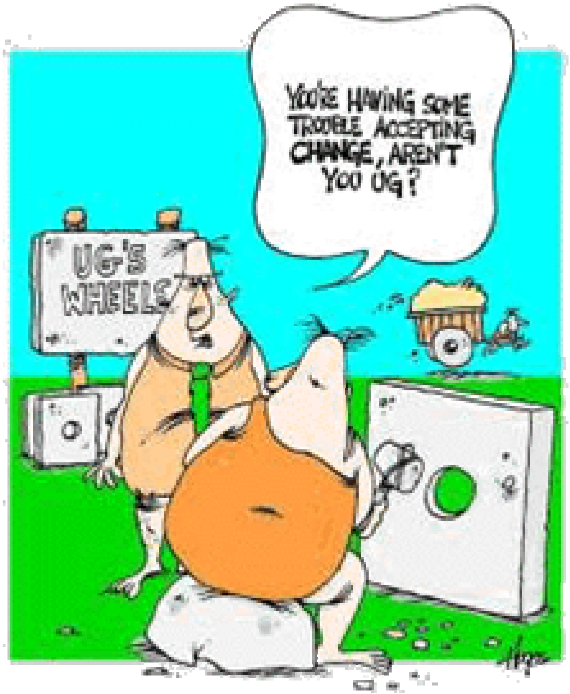
Managing Resistance - 2

How People Resist

- “Can’t do it!”: Skill (Training Issue)
- “Won’t do it!”: Motivation (Management Issue)

2 Types of Resistance

- Overt
- Covert



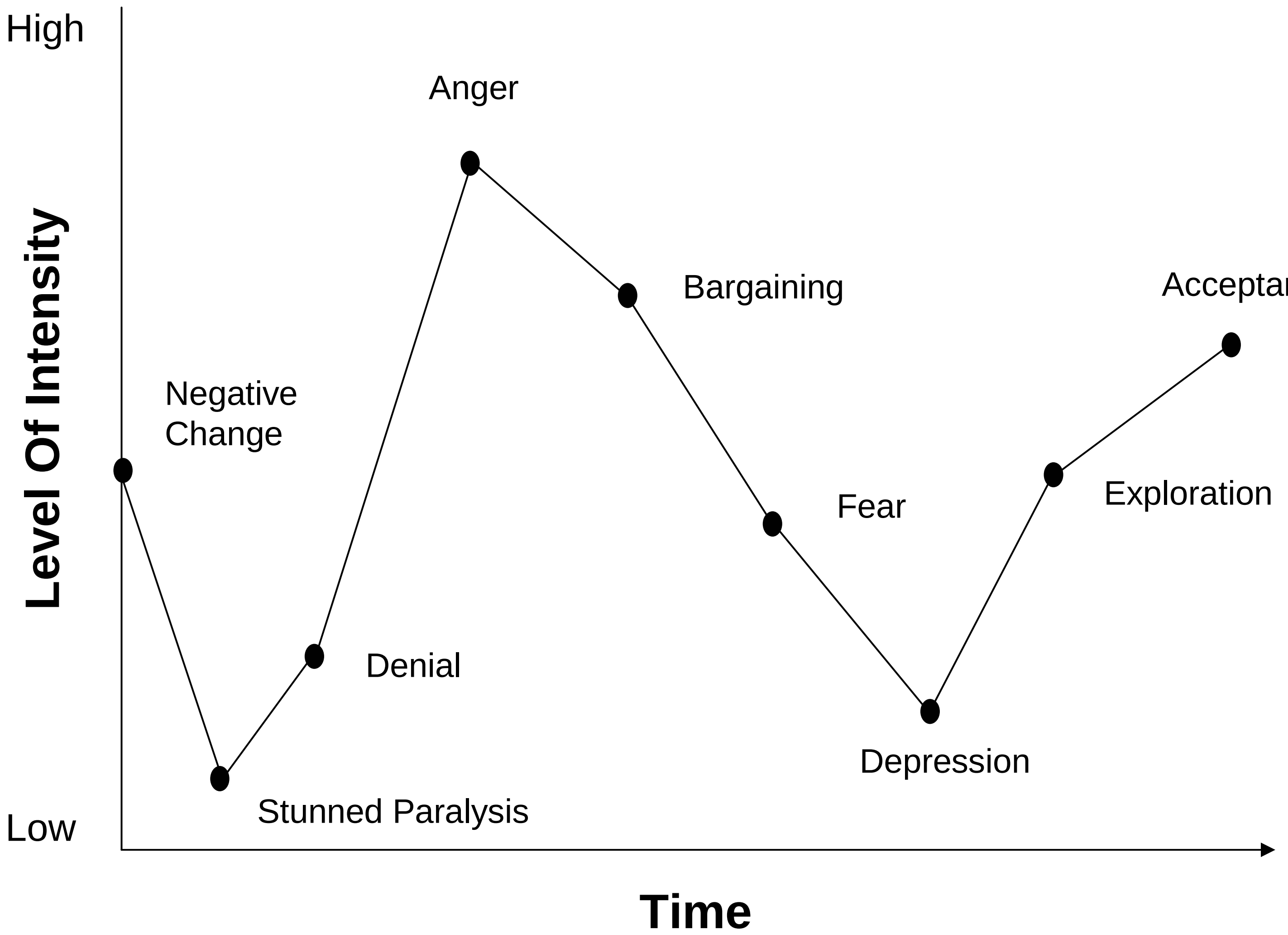
Forms of Resistance - 1

- **Give me more detail:** Continual requests for more information; no matter how much you give, it's never enough (appraisal interview experience)
- **Flood you with detail:** More and more information is provided that you understand less and less.
- **Time:** They never have enough time to meet with you, meetings that you do have are continually interrupted by calls or by people who "drop by".
- **Impracticality:** The person keeps reminding you that they live in the **Real World**.
- **I'm not surprised:** No matter what bizarre and unexpected things happen in a project, they claim they are not surprised.

Forms of Resistance - 2

- **Attack:** You are attacked with angry words, a red face, pounding on the desk, pointing a finger in your face, and punctuating the end of every sentence.
- **Confusion:** They claim to be continually confused, even after you have explained things two or three times.
- **Silence:** No reaction or response, even when you push hard for concurrence or objections.
- **Intellectualizing:** The person wants to discuss theory after theory about why things are the way they are.
- **Compliance:** They totally agree with you and eagerly wants to know what to do next. No reservations are ever expressed; the implication is that whatever you do is fine.
- **Pressing for solutions:** They want to rush headlong into solutions, without spending the time necessary to clearly identify and analyze the problem(s).

Reaction Pattern to Change viewed as Negative



Managing Complex Change

Vision	Skills	Incentives	Resources	Action Plan	→ Change
	Skills	Incentives	Resources	Action Plan	→ Confusion
Vision		Incentives	Resources	Action Plan	→ Anxiety
Vision	Skills		Resources	Action Plan	→ Gradual Change
Vision	Skills	Incentives		Action Plan	→ Frustration
Vision	Skills	Incentives	Resources		→ False Starts

Challenges to Change in L1 Organization - 1

- Resources
  - Lack of sufficient resources leads to frustration in bringing about change
  - Budget for instituting a change should be established and supported just as the budget for a development project

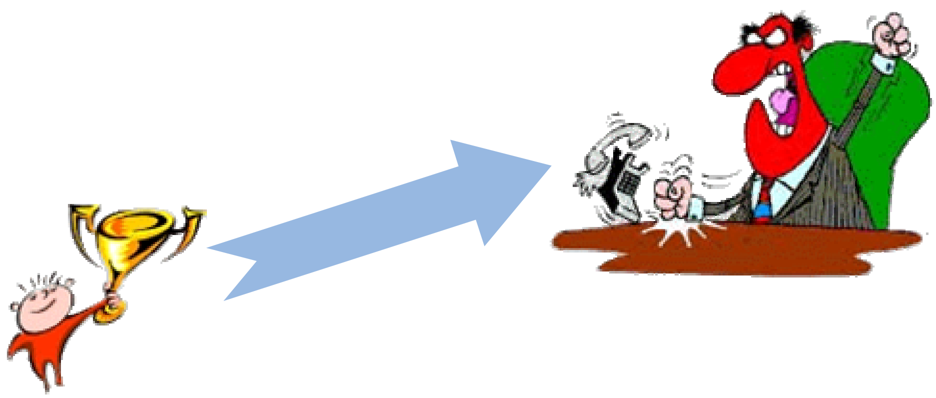
Challenges to Change in L1 Organization - 2

- Training
  - Not a high priority for Level 1 organizations
  - But training is typically a key component in rolling out any change

- Sponsor
  - A level 1 sponsor presents one of the biggest challenges
  - The sponsor must support and “own” the change before the organization will accept the change

Challenges to Change in L1 Organization - 3

- Don’t reward bad behavior - even the sponsor’s!
  - “Managers Behaving Badly”
  - Rewarding/Responding to bad behavior encourages/perpetuates it!
  - Sponsors that rule by intimidation, cursing, and general instability are not in support of positive change

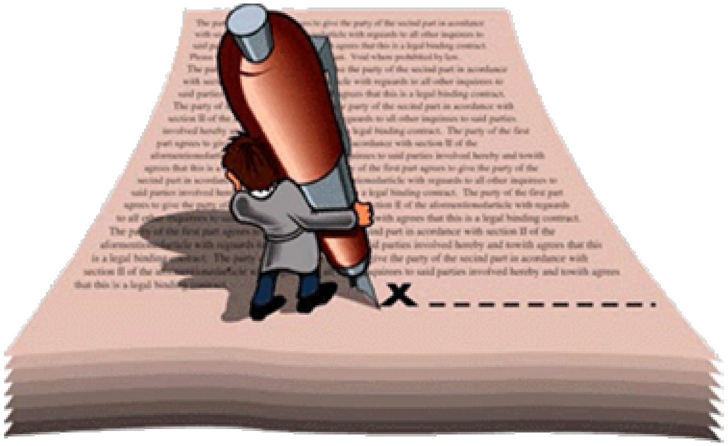


How to be a Change Agent in a L1 Organization - 1

- "Contract" with your Sponsor
  - Understand the Sponsor's expectations of the change effort
  - Understand what the change effort needs from the Sponsor in order to be successful
  - Create a "contract"
    - Reach a common understanding with the Sponsor of his/her expectations and also what is required from the Sponsor.
    - Does not necessarily result in a formal/legal 'contract'
    - However, the resultant commitments should be documented and approved (e.g., include in Process Improvement Plan)

How to be a Change Agent in a L1 Organization - 2

- "Re-Contract" with your Sponsor
  - "Re-Contracting" is necessary when support from your Sponsor is less than committed. (the improvement effort is being negatively impacted)
  - It is the responsibility of the Change Agent to have a meeting with the Sponsor to resolve/re-negotiate.
    - Usually the Sponsor needs only a reminder.
    - Offer to "ghost write" drafts of communications if this would be helpful.



How to be a Change Agent in a L1 Organization - 3

- The lifeguard approach
  - Let the organization move forward on their own
  - Make sure they follow the rules
  - Jump in if the effort is floundering

- Demand (at least) Level 2 behavior from those responsible for change
  - “Practice what you preach”

How to be a Change Agent in a L1 Organization - 4

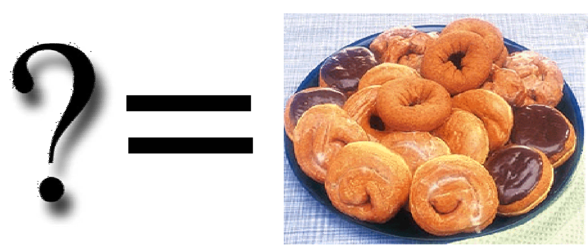
- Ride the bull
  - You may go through some difficult times when instituting a change, but hold on tight, be persistent.
  - “If ya ride the bull, you’re going to get some bruises!”
- Know when to step back
  - Important that the organization, not just the change agent is passionate about the change
- It’s not about you doing all of the work
  - Be a catalyst and provide support
  - The organization needs to make the change happen

How to be a Change Agent in a L1 Organization - 5

- Don’t underestimate the power of brochures and posters
  - Constant reminders keep awareness of the change at a high level

- Training “on the cheap”
  - Lunchtime seminars
  - Newsletters

- Promotions
  - Lollipop tree
  - Questions – Donuts
  - PowerPoint presentation cycling in the main lobby



Creative Ways of Measuring/Advertising Success - 1

- The importance of low-hanging fruit
  - Pick the fruit while it's ripe
  - Share with others
  - Don't take credit for the tree or the fruit
  - Make a pie when appropriate
    - Set it on the window sill to cool so that all of the neighbors can enjoy
  - Open up a fruit stand

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Creative Ways of Measuring/Advertising Success - 2

- Reward and Recognition
  - You don't have to spend a fortune
  - Little things mean a lot
- Posters
  - "Turtles"
  - "Traffic lights"
  - Dare to be different!

Wrap-up/Summary

- Being a Change Agent is sometimes just a matter of survival and the opportunity to seek shelter!
- However, the toughest jobs are also the most rewarding.
- Being a Change Agent is not for the timid or shy.
- By bringing a bit of creativity and a lot of determination and patience, you can prevail!
- Being a “Target” at least ensures that you get a lot of attention. ;-)

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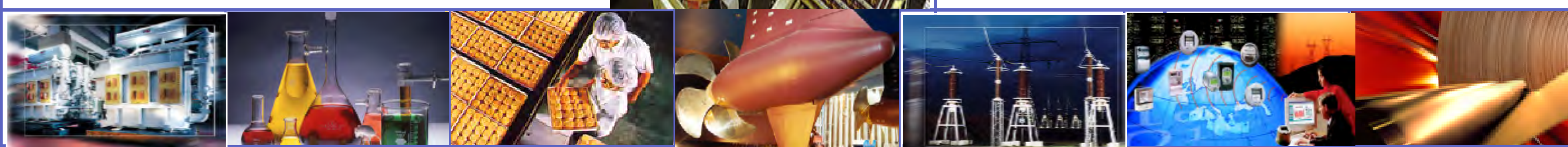
ABB

Strategic Planning: Selling a CMMI-based Improvement Effort to Senior Management

Aldo Dagnino and Andy Cordes

ABB Inc.
US Corporate Research Center
Raleigh, NC



Agenda

- ABB Overview
- Selling CMMI-based Improvement to Senior Management
  - Business Unit Level
  - Business Area Level
  - As a Strategic Technology at the Division Level
- Supporting CMMI-based Improvement as a Strategic Technology
- Summary

ABB Overview

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- Enable utility and industry customers to improve performance while lowering environmental impact
- The ABB Group of companies operates in more than 120 countries and employs approximately 110,000 people
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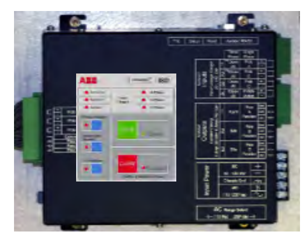
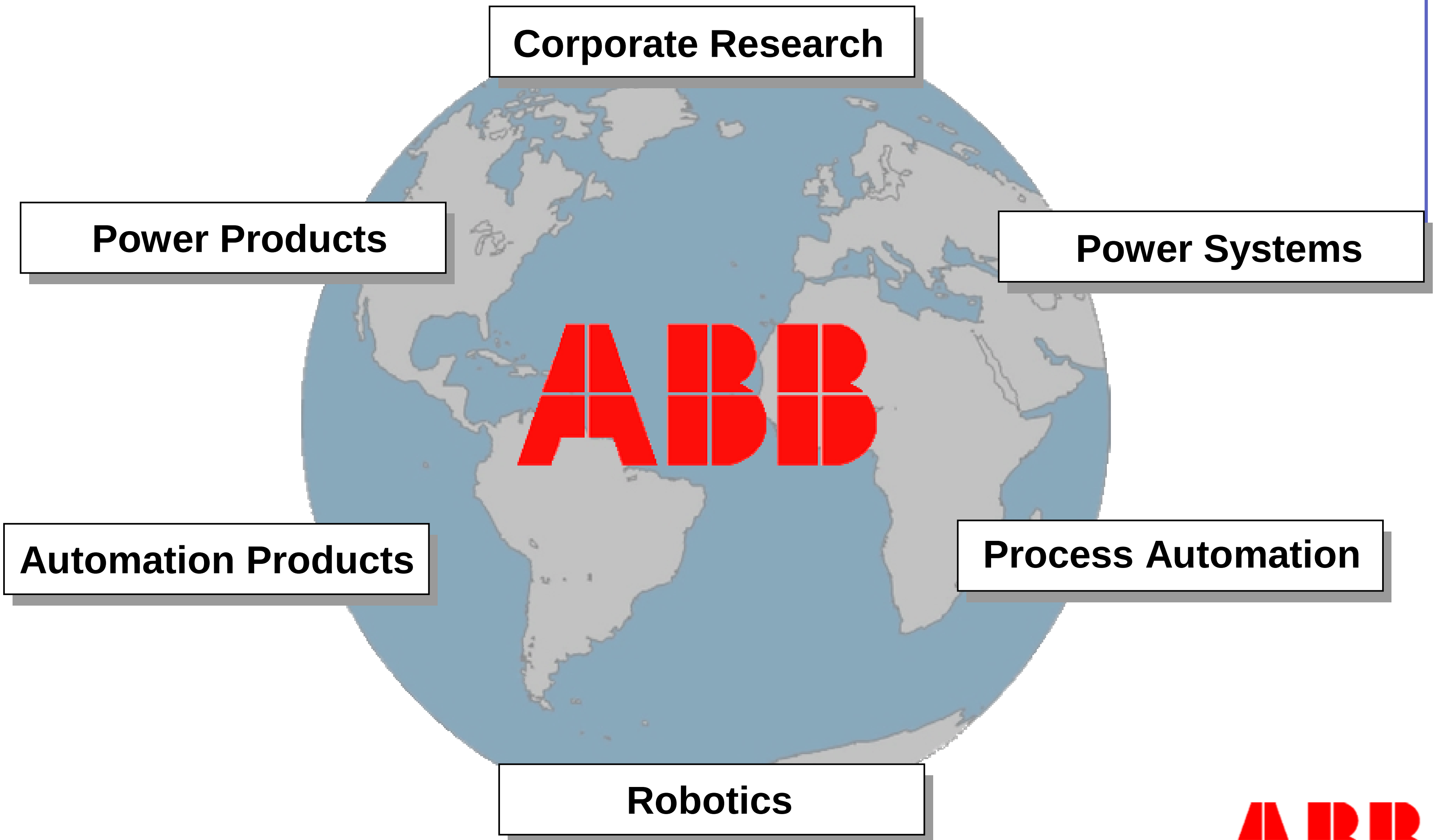


ABB's Organizational Structure



ABB's Products

- Power Products
- Power Systems

ABB's Products

- Automation Products
- Process Automation
- Robotics

- ABB Software Process Initiative (ASPI)
- ASPI is composed of members from 2 ABB Corporate Research Centers (CRCs):
  - United States: Raleigh
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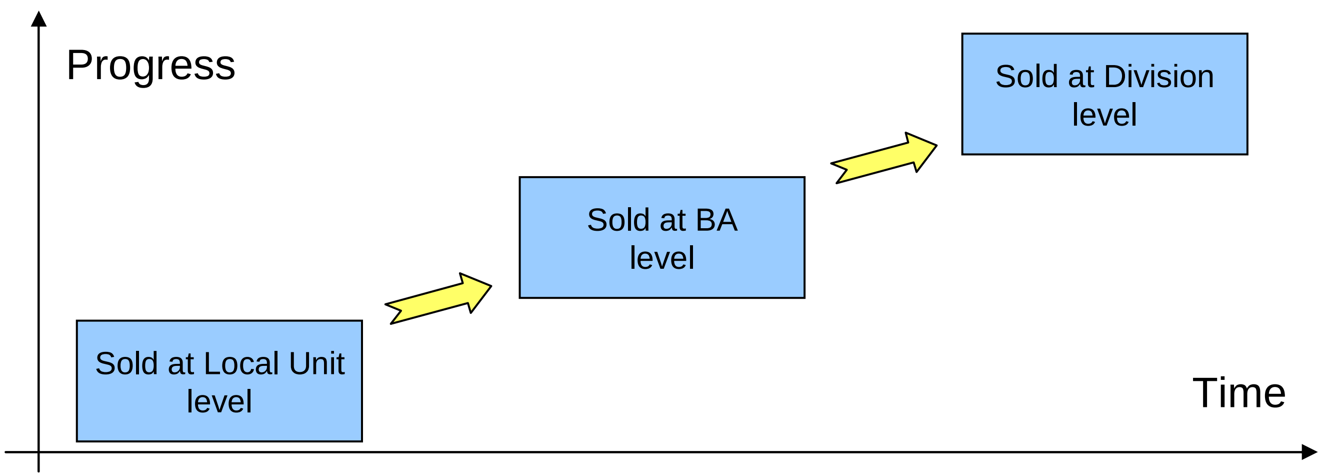
- Responsible for: Development of appraisal and improvement methodologies, evaluation and deployment of pilots within ABB for CMMI transition, PSP/TSP, etc.

Evolutionary Approach to Selling CMMI-based Improvements in ABB

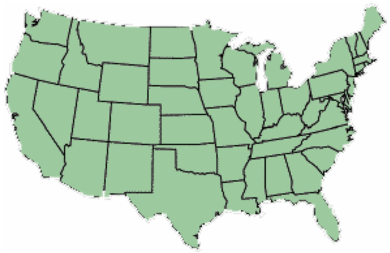
- First phase:
  - CMMI sold at the level of local product development units
- Second phase:
  - CMMI sold at the level of Business Area within a geographic region as a project
- Third phase:
  - CMMI sold at the Division level as a strategic technology



CMMI Sold at Local Product Development Units

- Characteristics of effort:
  - At the beginning of the Process Improvement Program, the selling effort was focused on local development units
  - Units are relatively small organizations
  - No history of CMMI-related benefits within ABB was available
  - CEPG needed high level of training
  - CEPG needed to develop support tools and methodologies
  - Product development projects always have priority over process improvement activities
- Lessons learned
  - Commitment highly dependent on local organizational changes
  - Commitments are short-term due to annual budget constraints and short-term changes (I'm not sure what you mean by "short-term changes")
  - High degree of flexibility within the organization to make changes
  - High budget constraints of local development units (is this covered in the second bullet?)
  - No synchronization of improvement activities and solutions with other units in the same group
  - Commitment to process improvement based primarily on sponsor's beliefs rather than business objectives
  - Need to constantly monitor commitment from sponsor and organization

CMMI Sold at Business Area (BA) within a Geographic Region



- Characteristics of effort:
  - A BA consists of clusters of development units
  - CMMI-based improvement was sold as a unifying activity to the BA managers within geographic regions
  - Process improvement activities were viewed a projects that compete for resources with product development projects
  - CMMI-based activities sold as projects competing with product development projects
- Lessons learned
  - Commitment to CMMI not as highly dependent on organizational changes
  - Commitment to process improvement based more on business benefits
  - Need to have a portfolio of documented benefits of CMMI-based process improvement efforts
  - Commitment to CMMI-based improvement medium-term
  - Some level of coordination among development units within the region

CMMI Sold at the Division Level as a Strategic Technology

- Characteristics of effort
  - Clear business objective needs to be defined
  - Commitment is sold at high Senior Management level
  - Process improvement is considered as a program not a project
  - Senior Management supports program at the global Division level
  - Longer term commitments are established
  - Process improvement is seen as competitive advantage
  - Process improvement is not as dependent on changes in organizational structure
  - Local development units receive funding and objectives from higher-up in the organization

Process to Sell CMMI as a Strategic Technology

Process for any Strategic Technology

Corporate Research Program Manager selects Strategic Technology Plan (STP) Lead

Lead selects team members to develop STP

Review and document state-of-the-art in Strategic Technology proposed

Estimated Business and Technology impact in ABB

Identify current solution within ABB
- within a program
- in other programs
- academia collaborations
- existing BU projects

Identify proposed solution within ABB
- anticipated results
- collaboration with BUs
- collaboration with academia
- competences required
- estimates of costs
- estimate of potential revenues

Application to CMMI-based Process Improvement

Selection of STP lead from CEPG

Engagement of CEPG members and potential partners in Development Units

Identify new developments in CMMI and other process improvement related fields

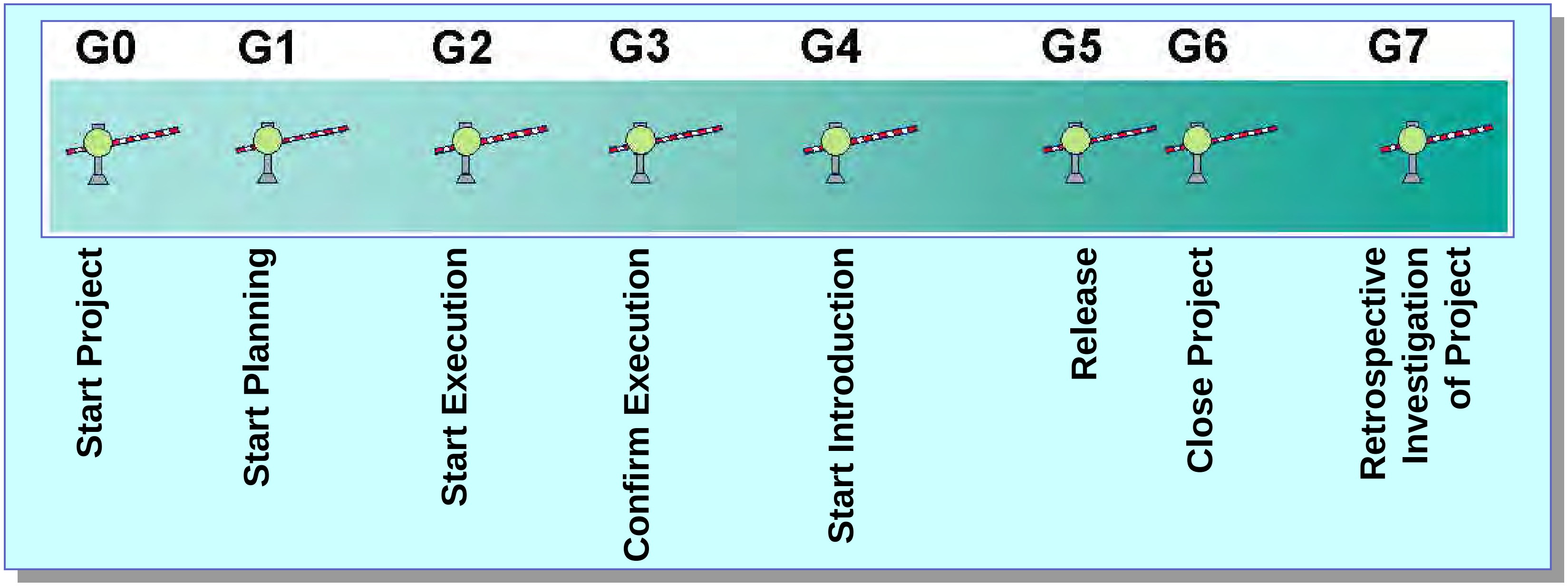
Identify benefits within ABB both quantitative and non-quantitative

Analyze current improvement projects with BUs and their impact. Assess current collaborations

Develop a plan for the future and outline the importance of CMMI as a strategic technology

ABB

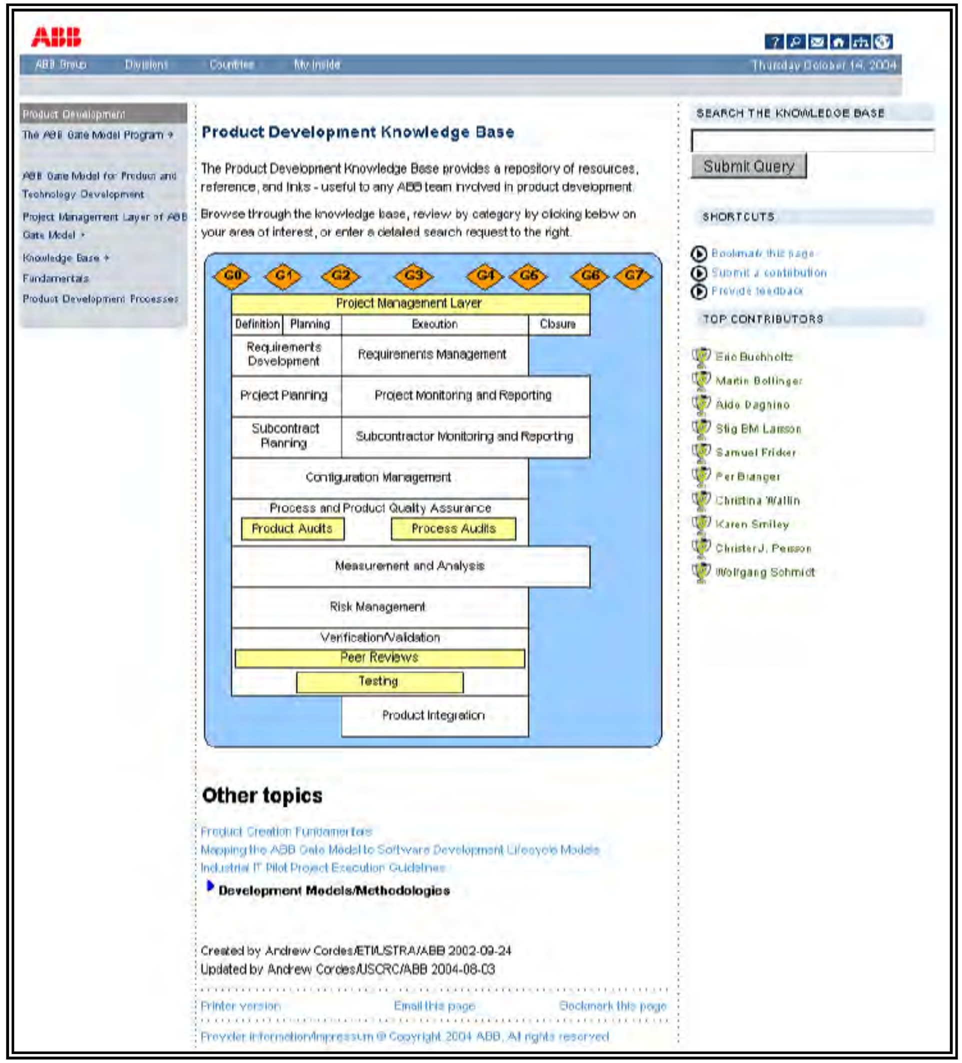
Use of the ABB Gate Model for CMMI-based Process Improvement Projects



- ABB Gate model used on all projects to ensure that:
  - Projects are linked to strategy and business requirements
  - Projects are executed in control of the management
  - Project investment is structured in phases to minimize risk
  - Projects are visible and transparent to the organization
  - Project deliverables have the right quality
  - Projects are delivering the benefits as promised
- CMMI-based improvement projects follow the Gate Model as well
  - Keeps the focus on the business benefits of the improvement effort
  - Actively involves management

Supporting CMMI-based Process Improvement as a Strategic Technology – Knowledge Base

- One-stop web-based source for Product Development Resources and Best Practices – Organized by CMMI Process Area
- Target Audience: Change Agents, QA, Project Managers
- Monthly reminder e-mails listing new additions
- Top contributors recognized
- Weekly metrics collected and analyzed to gauge the effectiveness of the knowledge base



Supporting CMMI-based Process Improvement as a Strategic Technology – Newsletters

- Purpose:
  - “Provide insight into good product development practices”
- Issued quarterly via rich-text e-mail
- Concise, easy-to-digest
- Contents:
  - Conference reports
  - Brief summaries of new technologies
  - Successful ABB development practices
  - Development/Process Improvement cartoon
  - Etc.

Development Practices Newsletter

ASPI ABB SOFTWARE PROCESS INITIATIVE

July 2004 - Volume 1, Issue 2

Contents

1. Welcome
2. 9th European Software Engineering Process Group Conference Report
3. Security in Products
4. Agile Software Development in Large Organizations
5. Food for Thought
6. Subscription Information

Welcome

Welcome to the Development Practices Newsletter. This newsletter will be published on a quarterly basis and will provide insight into good product development practices for ABB employees associated with product development.

9th European Software Engineering Process Group Conference Report

The ninth European Software Engineering Process Group conference was held in London in June. Almost 400 attendees had the opportunity to take part in a program that included a Project Management Symposium, a Metrics Symposium, a number of tutorials, and the main conference sessions.

Three themes were observed: security and safety, engineers and process improvement, and finally metrics. All three themes are also connected. Security is of high importance for many applications. In the conference, it was obvious that the banking sector is in need of more secure solutions. Safety puts similar demands on software development and the conclusion that many draw from the problems is that products need to be designed with security and safety in mind. This leads to the fact that each engineer needs to understand the importance of quality and be involved in the process improvement efforts. A key for this is to define and use the right metrics, useful also for the engineers so that the individual can get valuable feedback on the work performed.

Lessons Learned

- Selling CMMI as a Strategic Technology at higher levels in the organization increases the probability of success of the effort
- It is essential to make a business case for CMMI-based improvements to sell them to Senior Management
- Tracking the economic benefits of CMMI-based improvements is essential
- Think Global and act Local brings the best of both worlds

Questions ?

Aldo Dagnino

Measuring Economic Benefits of Process Improvement in CMMI Level 1 Organizations

**ABB Inc.
US Corporate Research Center
Raleigh, NC**



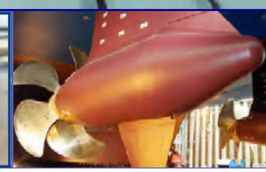
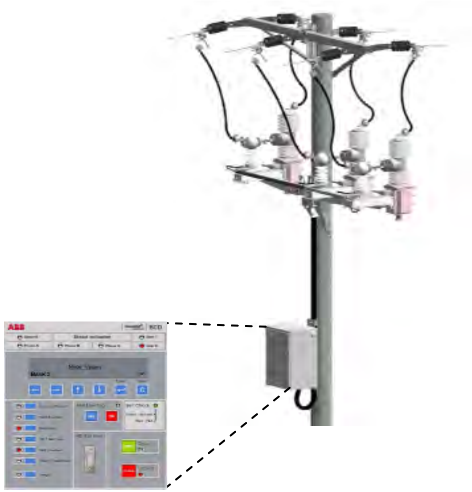
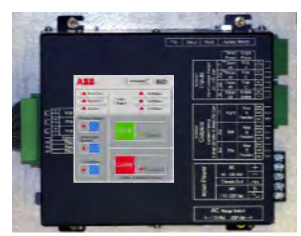



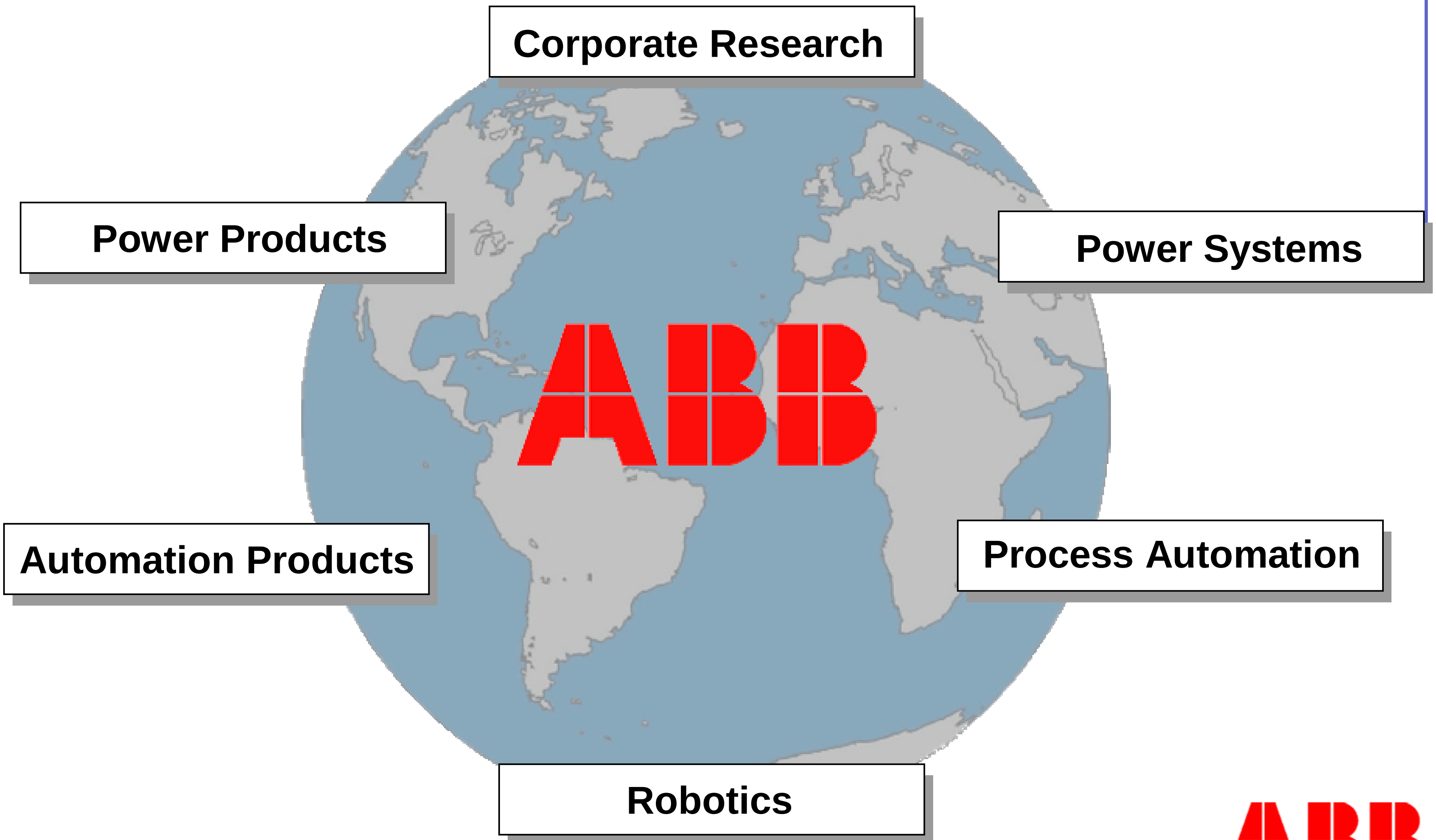

ABB Overview

- Leader in power and automation technologies
- Enable utility and industry customers to improve performance while lowering environmental impact
- ABB's products help operate Utilities, process industries, manufacturing plants, and other industries
- Present in over 120 countries and employs 110,000 people
- First company in the world to sell 100,000 robots
- A vast majority of ABB products have software & hardware components





ABB's Organizational Structure



ABB's Products

- Power Products
- Power Systems

ABB's Products

- Automation Products
- Process Automation
- Robotics







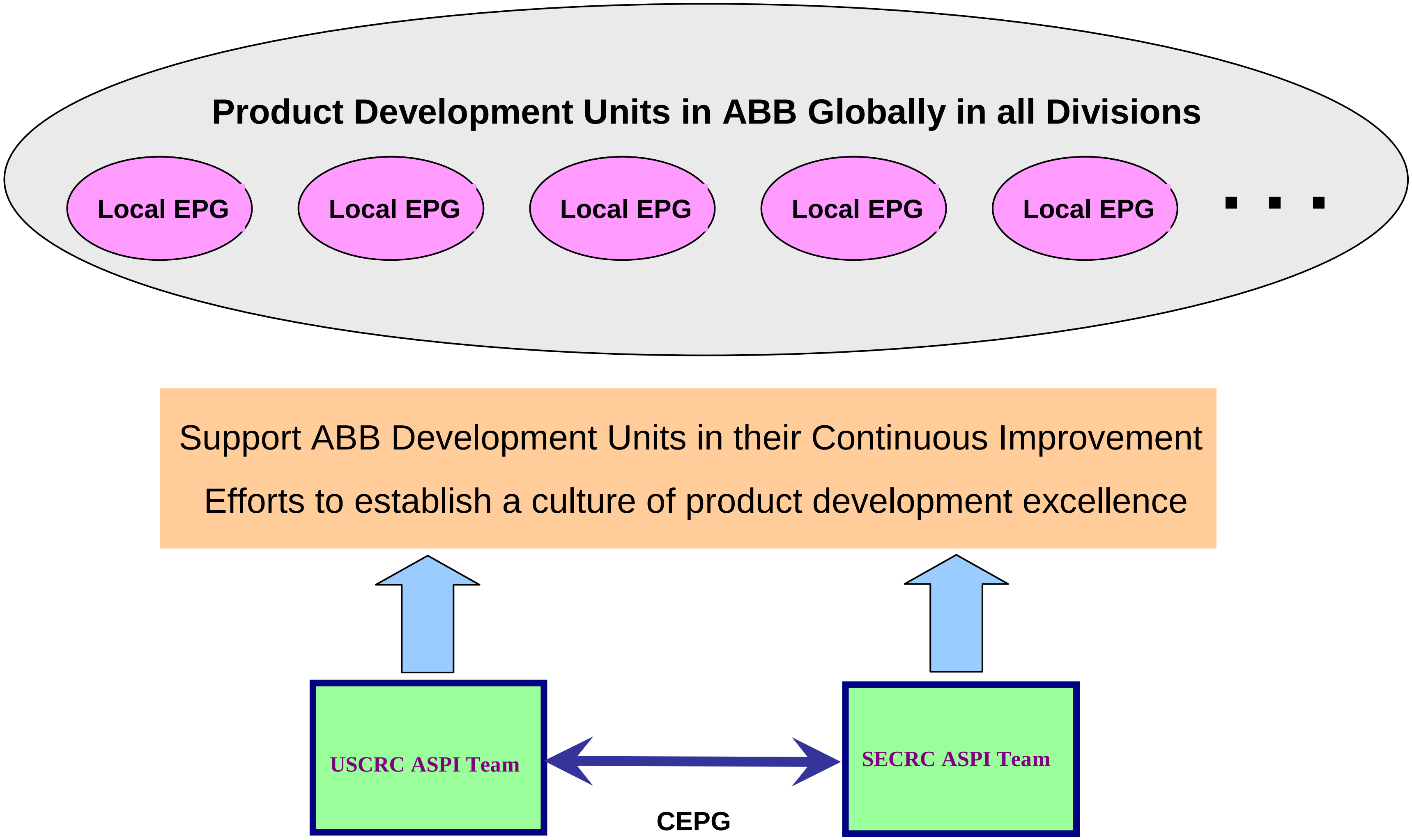

ABB

ASPI ABB SOFTWARE PROCESS INITIATIVE

- ABB Software Process Initiative (ASPI) acts as the Corporate Engineering Process Group
- ASPI is composed of members from 2 ABB Corporate Research Centers (CRCs):
  - United States: Raleigh
  - Sweden: Vasteras
- Responsible for:
  - Initiation activities
  - Performance of appraisals
  - Development of improvement methodologies,
  - Evaluation and deployment of pilots within ABB for CMMI transition, PSP/TSP, etc.
  - Assisting units in establishing improvement plans and acting
  - Collect lessons learned from process improvement activities

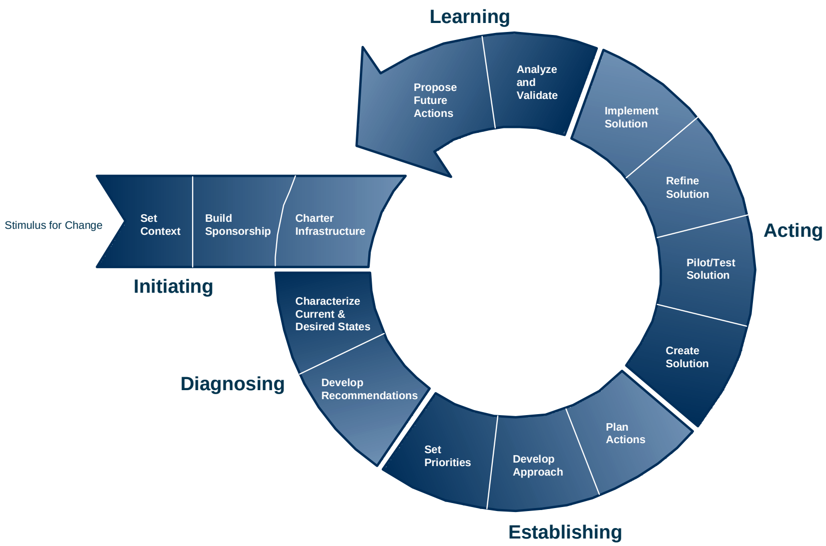
ABB

ABB Corporate EPG Support



Continuous Process Improvement Cycle

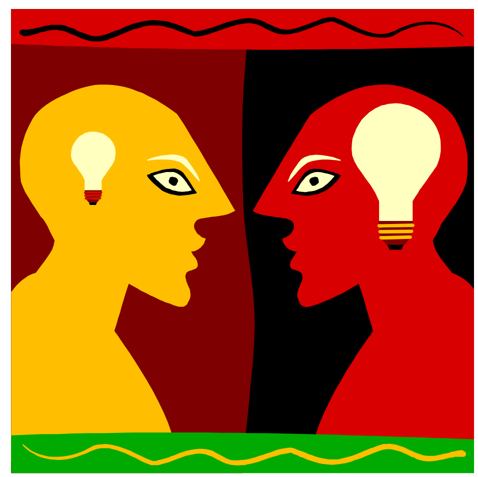
- Initiate Improvement activity
  - Define Medium/Long-term Strategic Improvement Plan (SIP) and identify organization's business goals
- Conduct internal CMMI Appraisal (Class B)
- Develop Process Improvement Plan (PIP)
  - Prioritize process improvement activities using Business Objectives
- Implement PIP and monitor
- Lessons learned
- Re-Initiate



Process Improvement Driven by Competitive Advantage

- Primary customers of ABB are commercial organizations (Utilities, petrochemical industries, pharmaceutical, automotive, chemical plants, etc.)
- Motivation to improve is driven by business reasons
- When Maturity Level is not a business objective, prioritization of improvement activities is paramount

Process Improvement



Increase Competitive Advantage

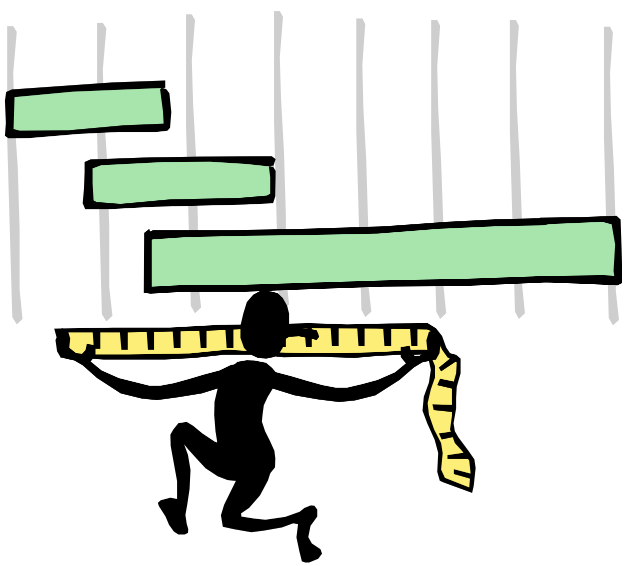
Results of Internal ABB Class B CMMI Appraisal

- Establishes a baseline in the organization
- Serves as a basis to identify process improvement activities
- Recommended to include the Measurement and Analysis Process Area

Practice	RD	ReqM	PP	PMC	MA	SAM	Ver	PPQA	CM
Specific Goal 1									
SP 1.1	Medium	Medium	High	High	High	High	High	High	High
SP 1.2	High	Medium	High	High	High	High	High	High	High
SP 1.3		High	High	High	High	High	High		High
SP 1.4		High	High	High	High				
SP 1.5		High		High					
SP 1.6				High					
SP 1.7				High					
Specific Goal 2									
SP 2.1	High		Medium	Medium	High	High	High	High	High
SP 2.2	High		High	High	High	High	High	High	High
SP 2.3	High		High	High	High	High	High		
SP 2.4			High		High	High			
SP 2.5			Medium						
SP 2.6			High						
SP 2.7			High						
Specific Goal 3									
SP 3.1	Medium		High				High		High
SP 3.2	Medium		High				High		High
SP 3.3	High		High						
SP 3.4	High								
SP 3.5	Medium								
Generic Goal 2									
GP 2.1	High	Medium	High	High	High	High	High	High	High
GP 2.2	Medium	High	High	High	High	Medium	High	High	High
GP 2.3	Medium	Medium	Medium	Medium	High	Medium	High	High	Medium
GP 2.4	High	High	High	High	High	Medium	Medium	High	High
GP 2.5	Medium	Medium	Medium	Medium	High	Medium	Medium	High	High
GP 2.6	Medium	High	High	High	High	Medium	High	High	Medium
GP 2.7	Medium	Medium	Medium	Medium	High	Medium	Medium	High	Low
GP 2.8	High	High	High	High	High	High	High	High	High
GP 2.9	High	High	High	High	High	High	High	High	High
GP 2.10	Low	Low	Low	Low	High	Low	Low	High	Low

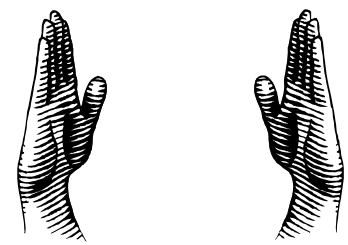
Measurement and Analysis

- Two Types of metrics:
  - Metrics associated with the product
  - Metrics associated with the development process



Typical Process-related MA in a CMMI Level 1 Organization

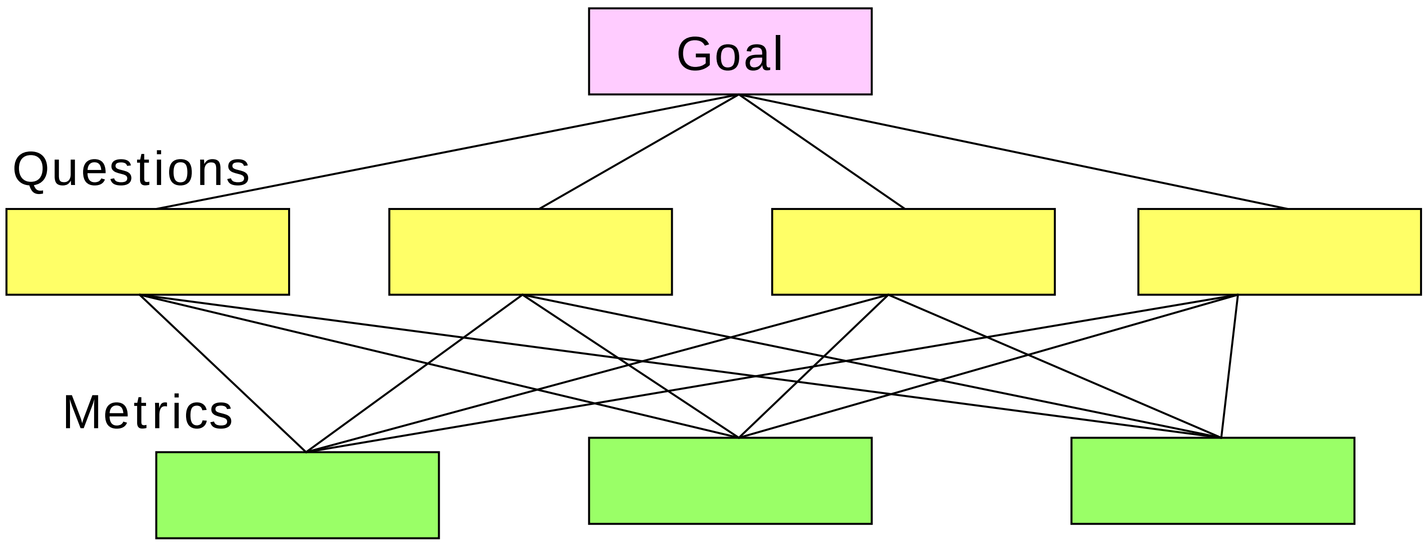
- Measurement Objectives for Process Improvement not clearly defined
  - Information needs and objectives are not consistently defined and documented
  - Measurement objectives are not consistently defined
  - Measurement objectives are not consistently aligned with information needs
- Specify Measures for Process Improvement
  - Quantifiable measures are not consistently traceable to measurement objectives
  - No clear definition between base and derived measures



- Collection and storage of specific measurement data associated with process improvement is not consistently defined
- Analysis and reporting of measurement data for process improvement is not consistently specified

Goal-Questions-Metrics Paradigm

- *GQM presents a systematic approach for integrating goals to models of the software processes, products and quality perspectives of interest based upon the specific needs of the project and the organization. (Basili et al, 1994).*

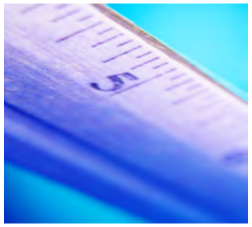


GQM Definitions

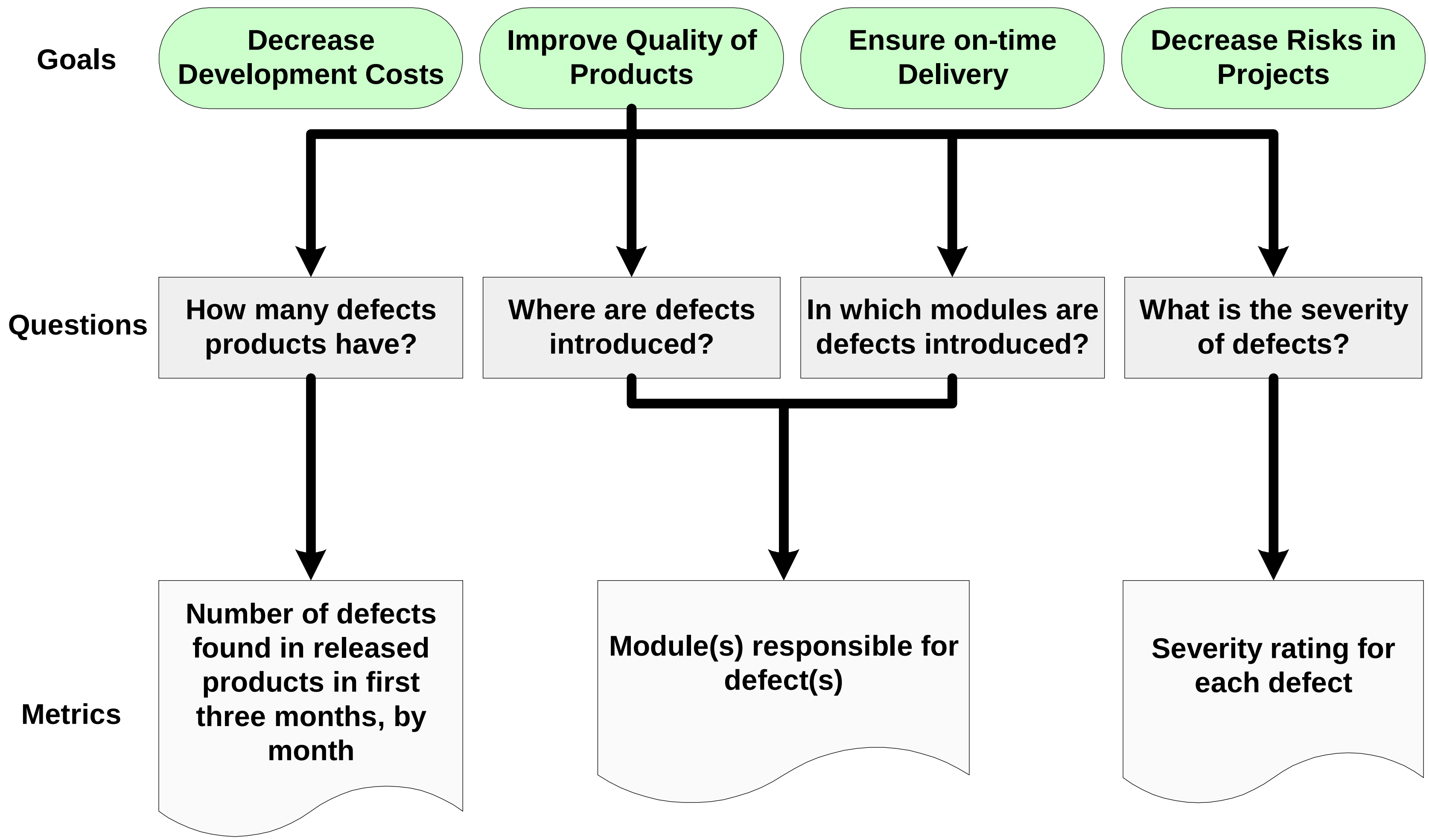
- Define major goals of the process improvement activity

- Questions derived from goals that must be answered to determine if the goals are achieved

- Measurements that provide the most appropriate information for answering the identified questions

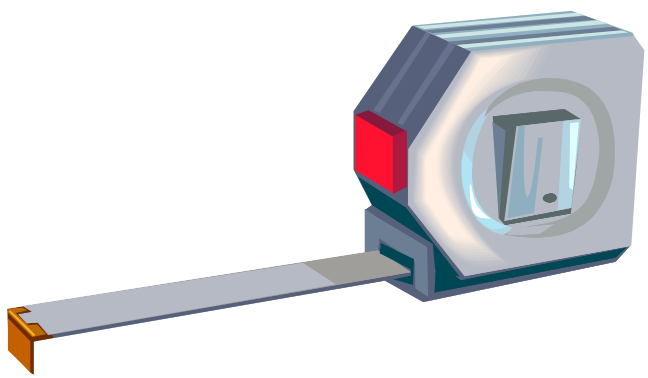


Example of GQM for Process Measurement



Product Development Process Metrics

- Typically associated with:
  - Consumption of resources during a process
  - Process control
  - Errors or faults associated with a particular process



Example of Development Process Metrics

- Management control metrics
  - Deviation between actual and estimates
  - Deviation from promised final delivery
- Test coverage metrics
  - Number of defects introduced
  - Cost of reducing defects
  - Where defects are introduced
  - Error distribution by cause
- Effort
  - Person/time metrics (not elapsed but actual)
- Time
  - Time to market metrics
- Productivity
  - Software output per unit of input

Discussion of an Example at ABB

Please refer to Handouts to follow specific Example discussion

Lessons Learned

- A CMMI appraisal provides the foundation for process improvement
- Using the GQM approach is a useful way to establish a metrics program for process improvement
- Establish Goals from business objectives
- Business objectives should be employed to prioritize process improvement activities after appraisal has been conducted
- Use the CMMI Measurement and Analysis process area practices to establish metrics for process improvement
- Process improvement should include the MA process area together with any other improvement to ensure meaningful measurements are obtained
- Start small and simple

Questions ?

Raytheon
Customer Success Is Our Mission

Finding CMMI Compliant Artifacts and A Needle In A Haystack

Presented to National Defense Industrial Association
Fifth Annual CMMI Technology Conference and User Group
Denver, Colorado

Adrio DeCicco
Space and Airborne Systems
Raytheon El Segundo, CA
November 17-20, 2005

You Are Tasked To Find CMMI Compliant Data For An Upcoming Appraisal

- You meet with some program leads who show you the program server and where their documents are

- You start with Project Planning (PP) and Project Monitoring and Control (PMC)

  – You begin to locate documents for the each of the process areas

  – You create a matrix and populate the matrix with documents for each of the process areas

  – You cannot find data for some practices, so you question the leads

    PP GP 2.10, Review the activities, status, and results of the project planning process with higher level management and resolve issues

      The program manager is not available, however the leads provide you with program reviews

You Continue To Collect Artifacts

- - Some examples of your data collection activities:
  - For PP, SP 2.7 Establish and maintain the overall project plan content:

    You provide the program management, systems, software, risk, and quality plans.
  - For PMC, SP 1.1 Monitor the actual values of the project planning parameters against the project plan:

    You look at the examples suggested in the model's sub-practices and you provide the program schedule and a schedule of resources
  - For PMC, SP 1.3 Monitor risks against those identified in the project plan:

    You provide a list of hardware and software risks
  - For PMC, SP 1.6 Periodically review the projects progress, performance, and issues:

    You provide a design review

You Completed Data Collection And Are Ready For The Appraisal

– You feel good about what you have done and expect to get favorable results from the upcoming appraisal

– Collecting data was a lot of work but you felt it was not difficult

The Appraisal Results Are Not Favorable

– There are many observations from the appraisers

For PP, SP 2.7 Establish and maintain the overall project plan content:

You provided the program management, systems, software, risk, and quality plans

» Some plans are not signed

» There is no evidence of “maintain” as all plans are a Rev (-)

For PMC, SP 1.1 Monitor the actual values of the project planning parameters against the project plan:

You provided the program schedule and a schedule of resources

» The schedules are not updated nor show actuals

For PMC, SP 1.3 Monitor risks against those identified in the project plan:

You provided a list of hardware and software risks

» The risks are not the same ones shown in the program’s risk register

For PMC, SP 1.6 Periodically review the projects progress, performance, and issues:

You provided a design review

» It is not applicable here. Move it to SP 1.7, Review the accomplishments and results of the project at selected project milestones. Provide other program or team reviews, not milestone reviews

More Observations From The Appraisers

- Plans are not direct evidence unless shown in Project Planning
- List of action items does not describe the closure activity
- Reviews with higher level management do not show line management attended
- GP 2.5 Train the People: the training records of the people shown are not the same as the org charts (GP 2.4) or charge numbers people used in providing resources (GP 2.3)
- ISO audit does not show evidence of objective evaluation because it does not include many of the sub-practices of the subject process area
- Little systems engineering evidence was provided for at least one program
- Data is “old”
- The SAM process appears to have stopped two years ago

Fallout From The Appraisal

- You are now convinced that finding CMMI compliant data is like finding a needle in a haystack!
  - As a matter of fact, it is more like finding a needle in Field of Hay!

Sorting Out The Needle From The Hay

- Prior to an appraisal understand what is expected from the appraisal team and what you expect
  - What constitutes “enough” artifacts
    - Two directs and two indirects (per practice, sub-practice, discipline, etc.)
  - What constitutes compliancy to the model
    - Meet the intent of the goal
    - Provide evidence for all practices
    - Provide evidence for all sub-practices
  - Educate the appraisal team on how your business / organization operates
    - Provide overviews from each appraisal program and your organization
      - Size, life cycle, what is being built and how and by whom (disciplines), etc.
  - Communicate your goals
    - Need help to improve a certain business organization, discipline, etc.

Sorting Out The Needle From The Hay (Cont'd)

- Define terms for data collection guidance
  - "Goodness" – appraise plans for CMMI compliancy and do not judge the effectiveness of the plan
  - How "old" is "old?"
  - Understand "maintain" in "establish and maintain"
  - "Update" – changed plans, requirements, milestones, events
  - "Refresh" – recurring activities (meetings, monitor and control, etc.)

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Sorting Out The Needle From The Hay (Cont'd)

- Know how the appraisal team will operate
  - Will credit be given for artifacts seen in prior practices but not provided in other practices where they also apply?
  - Will appraisers external to your organization ask appraisers from your organization to help clarify data issues?
  - Similarly, will appraisers ask for help from other appraisers to help clarify data issues from a discipline they are not familiar with?

Sorting Out The Needle From The Hay (Cont'd)

- Describe how documents are organized for the appraisal
  - Spreadsheet, table, by discipline, etc.
  - Soft and / or hard copy of data
  - How classified, proprietary, etc. data will be provided
  - Data collection threads
  - Comments explaining why the data is relevant

Documentation Issues

PP

PM Plan
SE Plan
SW Plan

PMC

PM Plan
SE Plan
SW Plan

CM

PM Plan
SE Plan
SW Plan

GPs

PM Plan
SE Plan
SW Plan

Using The Same Documents Leaves A Data Collection Trail)

PM Plan
SE Plan
SW Plan

PM Plan
CM Plan
RSK Plan

MA Plan
VAL Plan
OT Plan

VER Plan
OT Plan
SW Plan

Using A Mixture Of Documents Makes It More Difficult To Understand The Evidence

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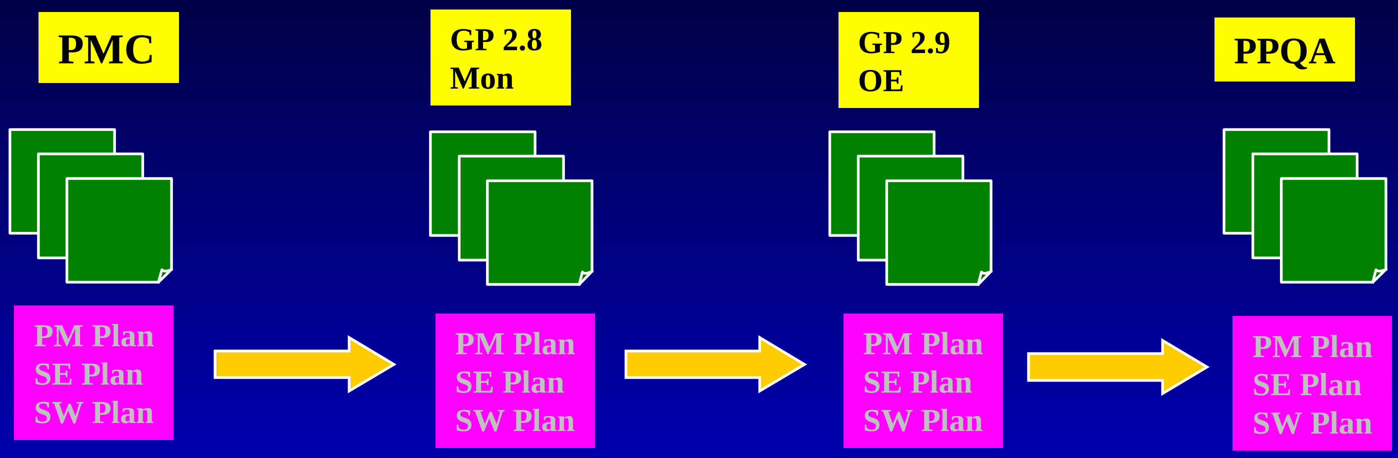
Documentation Issues



Some Issues/Considerations That Resulted From Appraisals:

- PMC:	Monitor Effort, Cost, And Schedule Against The Plan
- GP 2.8 (Monitor & Control):	Monitor & Control The Process Against The Plan
- GP 2.9 (Objective Eval):	Process Is Implemented As Planned
- PPQA, SP 2.1:	Can Be Little "q"; Not Necessarily Big "Q"
- GP 2.10 (Higher Level Mgt):	Should Have Actual Presentations & Meeting Minutes Attendee List, & Action Items Higher Level Management Is Senior Management; Not Program Management
- Documentation:	How Much Is Enough? Two Directs & Two Indirects? Need Directs & Indirects From PM, SE, & SW? Are Plans Indirects?

Other Issues

- Implementing CMMI Based Process Improvements On Legacy Programs
  - Introduce Process Improvements As Legacy Programs Enter A Major Milestone
    - Tailor The Organization’s Standard Process From That Point Forward
- Have A Senior Systems Engineer Or A Senior Software Engineer Be Responsible For Applicable Systems Engineering Activities On Predominantly Software Programs
- Time And Effort Trying To Produce Lessons Learned Artifacts For Every CMMI Process Area

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Conclusions

- Manage appraisal preparation like you would a program
  - Assign responsibility, obtain commitment (organization, program, and process), generate a schedule, resolve issues, monitor progress, and report status
- Determine who should identify documents
  - Process engineers or program personnel
- Form a capable team
  - Process engineers with CMMI training
  - Process engineers who can verify that the collected documents are CMMI compliant
  - Communication between data verifiers and collectors to understand what is expected to satisfy the model
    - Reviews and meetings need minutes, action items, attendee lists
    - Data threads; the plans shown in PP should be the same in PMC
- Appraisal team

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Summary

- Diverse Opinions Emerge On How To Define, Generate, And Implement CMMI Compliant Processes
  - Process Engineers, Appraisers, And Lead Appraisers Have Divergent Opinions On The Intent Of The Model And What Constitutes Compliancy
    - Detail And Architecture Of The Organization’s Standard Process
    - Artifact Collection: Type And Number Of Documents
    - Scope, Meaning, And Application Of Generic Practices
    - Correlating An Organization’s Daily Activities To CMMI Practices
- As A Result, At Times It Seems As If We Looking For A Needle In A Haystack

COMBINING SEVEN IPTS AND TRANSITIONING TO CMMI

Prepared for NDIA CMMI Conference

Abstract # 2631

14-17 Nov 2005

Judy Overhauser-Duett

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Background

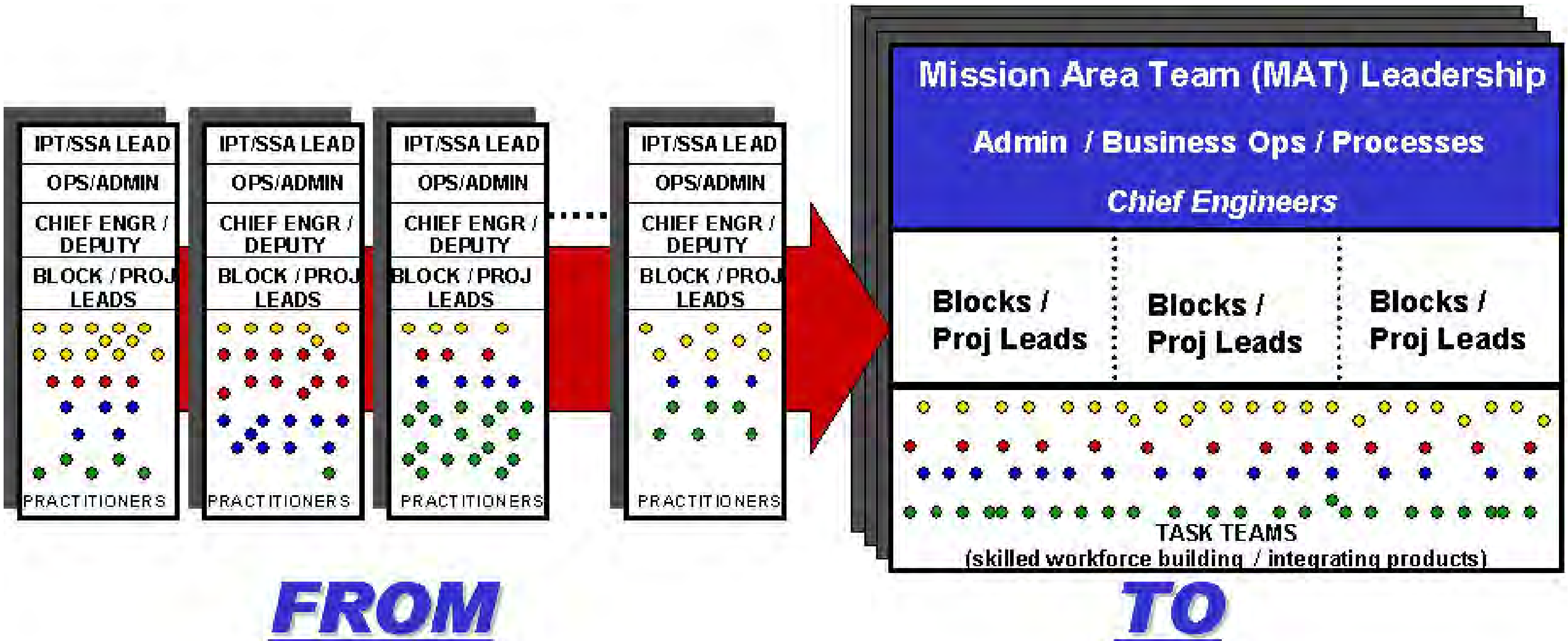
- From a Process Improvement (PI) viewpoint
  - Three (3) major sites
- Scope changed since abstract submitted
  - Added one more large Integrated Product Team (IPT)
- One of four Mission Area Teams (MATs) in NAVAIR
- Built on gains achieved by NAVAIR Software Process Improvement Community of Practice (SPI CoP)

  - All MAT PI Leads knew each other from SPI CoP

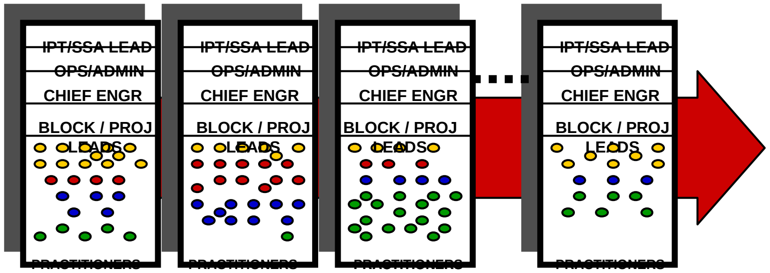
MAT Business Objective

- "The ever-increasing demand on software capabilities requires NAVAIR to exponentially increase its ability to consistently deliver high quality software at minimal cost" **February 2005 MAT/NSSC CONOPS**

MAT Architecture



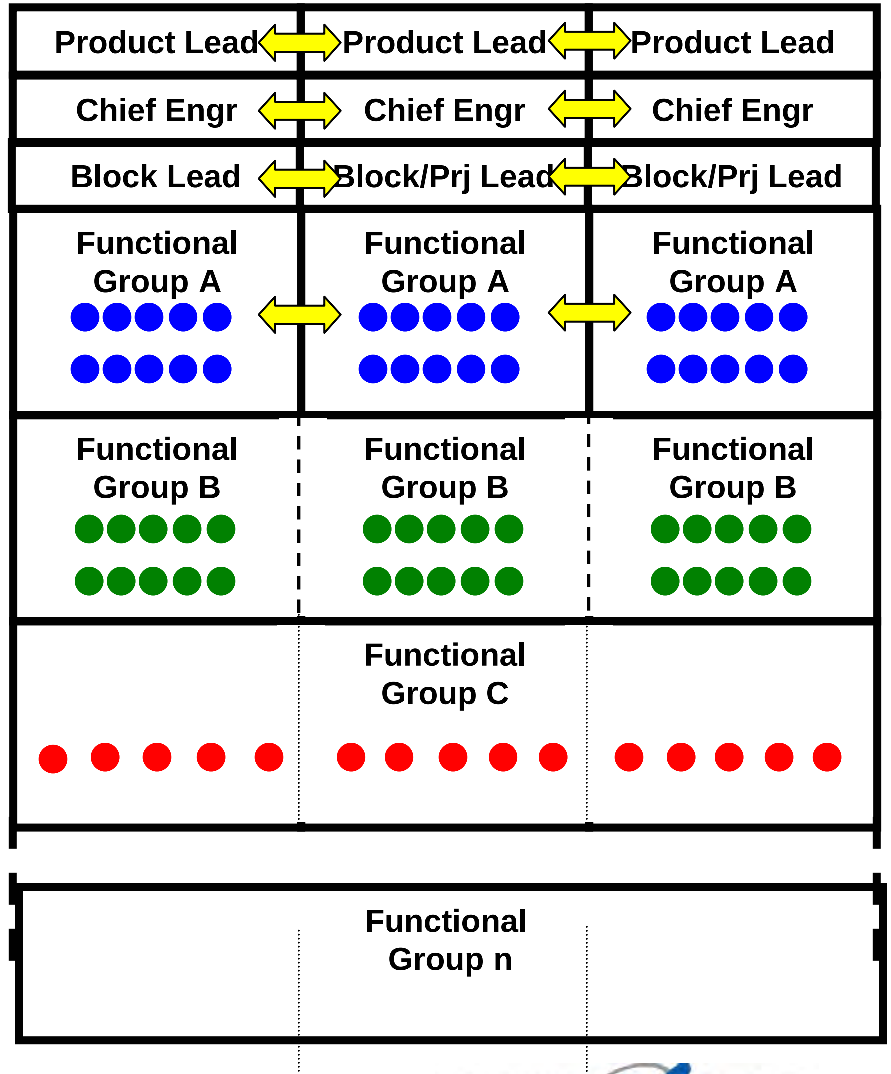
MAT Functional Groups



Certain functional groups will not flow between Product Teams, but we will develop communication bridges to flow information and best practices

Other groups will be available for planning across groups, but will require varying amounts of training to obtain proficiency

Some groups will flow rather seamlessly across the Product Teams



Communication Bridge

MAT Overarching Requirements

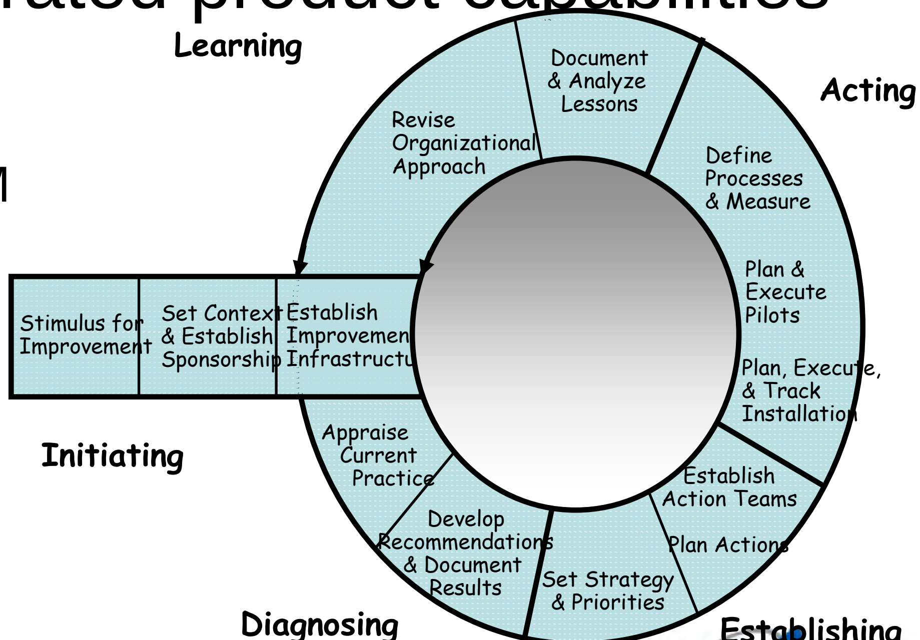
- Acquire, develop, maintain tactical systems software at reduced cost with acceptable risk
- Continuously improve quality, productivity, responsiveness, and predictability
- Ensure alignment to fleet requirements

MAT SSEPG

- PI Lead(s) from each of the IPT SSEPGs
- Decision making by consensus so far
- Worked together in SPI CoP by consensus before standing up MAT
- Equal vote for each SSEPG member
- Just hired SSEPG Lead to interface with MAT Leadership team

Aligning PI with CMMI

- NAVAIR Initiative
- NAVAIR products integrate software and systems functions
- CMM ignored integrated product capabilities
- Using SEI IDEAL[SM] model for initiating, planning, and implementing MAT PI



Aligning PI with $CMMI_2$

- Continuous representation and equivalent staging OR one huge SCAMPI
  - Determine process areas that apply to each IPT according to mission
  - Ensure MAT coverage across Maturity Level 3
  - Perform Class C gap analysis for each IPT
  - Fill holes
  - Conduct SCAMPI(s)

Chronology & Successes

- MAT SSEPG allowed to self-organize
  - Biggest success enabler
  - Facilitation/change management enabled progress
  - No major roadblocks
  - Each IPT donated PI Lead time to standup MAT SSEPG
  - Three co-located PI Leads (already meeting) expanded to include representatives from all seven (7) IPTs

Chronology & Successes$_2$

- Meeting 1 -Forming MAT SSEPG
  - Each PI Lead introduced self and described PI initiatives within their IPT
  - Draft charter
  - Consensus decision making process
  - Agreed that if IPT PI Lead did not attend or send rep they would live with the decisions made
- Meeting 2 - Initiating SSEPG
  - Each PI Lead expressed ideas for what SSEPG should be
  - Decided need SSEPG Lead and set meeting to write job description

Chronology & Successes$_3$

- Rotated representation to MAT Leadership meetings (May – Aug)
- Used virtual meetings
- Each IPT rewrote PI Plan for 4th quarter FY05 aligned with MAT objectives
- Leader appointed 9/30/2005

Chronology & Successes$_4$

- Strategic Plan – PI objectives aligned with MAT objectives
  - Meeting to produce first draft
  - Comments submitted
  - Online Peer review
  - WG proposed some final changes
  - Baselined 08/25/2005

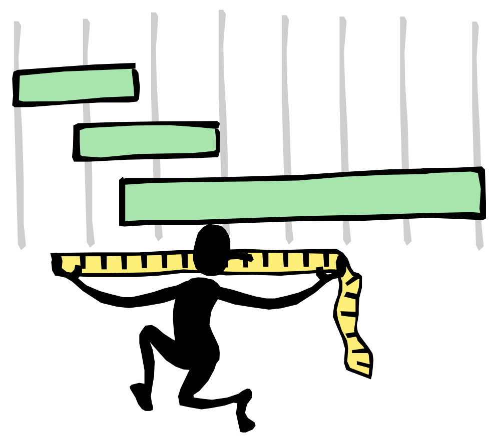
- Some members attended special Change Management workshop

Chronology & Successes$_5$

- Tactical planning
  - Stakeholder matrix
  - Brainstormed improvements to handle first
    - Each IPT prioritized
    - Added up scores of all the IPTs and used to get initial order
    - Proposed some changes in order which were voted and approved by consensus

Next Steps

- ❑ Finish initial planning
- ❑ Begin work on highest priorities
- ❑ Integrate PI with AIRSpeed?
  - Customer Value Added Definition
  - Collect Measures that quantify PI savings



NAVAIR

Lessons Learned

- Getting all PI Leads involved early enabled us to function as a team earlier
- Resistance melted with communication
- Change Management Facilitation allowed us to concentrate on the PI

Questions?

Backup Slides

Acronyms

AIRSpeed	Lean Six Sigma and Theory of Constraints
IDEAL℠	Initiating, Diagnosing, Establishing, Acting, and Learning
IPT	Integrated Product Team
MAT	Mission Area Team
NAVAIR	Naval Air Systems Command
PI	Process Improvement
SPI CoP	Software Process Improvement Community of Practice
SSEPG	Systems and Software Engineering Process Group
TOC	Theory of Constraints

Other NAVAIR Initiatives

- AIRSpeed (Lean Six Sigma with Theory of Constraints)
- Organizational Change Management

AIRSpeed

- Customer (Fleet) value-added viewpoint
  - Eliminate waste and time waiting on another process (Lean)
  - Ensure all steps are necessary (Lean)
  - Streamline processes to eliminate bottlenecks and maximize throughput (TOC)
  - Eliminate rework by controlling process (6σ)
- Realize real savings and recapitalize for investment in future

Organizational Change Management

- Enabler for both CMMI and AIRSpeed
- Train leaders in change management
- Assess current state
  - Awareness
  - Resistance/Obstacles
  - Knowledge and training required
- Plan change and implement plan
- Effective communication
  - Sponsorship
  - Feedback
  - Allow employees to “make a difference”

Lessons Learned on the SCAMPI Road to CMMI-Software Level 5

NDIA CMMI Technology Conference,
14-17 November 2005 Denver CO

Joseph N Frisina
Randall J Varga

One Road Towards

BAE SYSTEMS

- Formally assessed at Capability Maturity Model Integration (CMMI) **Software Engineering Maturity Level 5** and Systems Engineering / Program Management Maturity Level 3 on 15 December 2005.

  - The assessment was performed using the Carnegie Mellon University (CMU) Software Engineering Institute (SEI) CMMI **SCAMPI A** Appraisal method
  - Engineering and program management organizations were located **across three states**.

- The presentation will describe the planning and associated activities that led to this successful result and the lessons learned from those activities that were then **cycled into a continuing process improvement activity**.

Road to CMMI Software Level 5

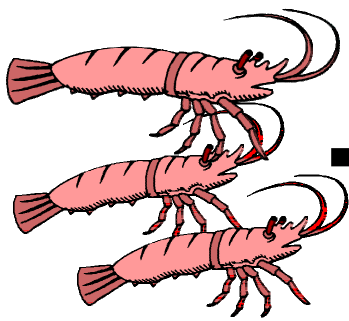
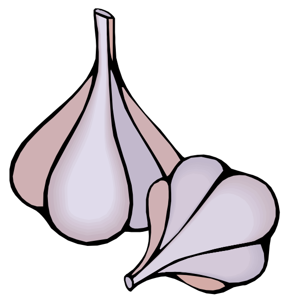
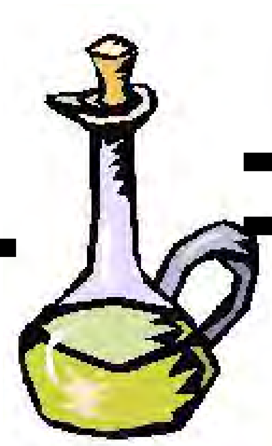
BAE SYSTEMS

– We developed a database approach to the collection and control of CMMI artifacts which proved to be a valuable resource during the SCAMPI Assessment.

– BAE Systems Software had been previously assessed at CMM level 5, and we developed transition approaches to the more comprehensive CMMI representation.

What is SCAMPI ?

SCAMPI – What is it?

 +  +  = 

$\neq$ **SCAMPI**

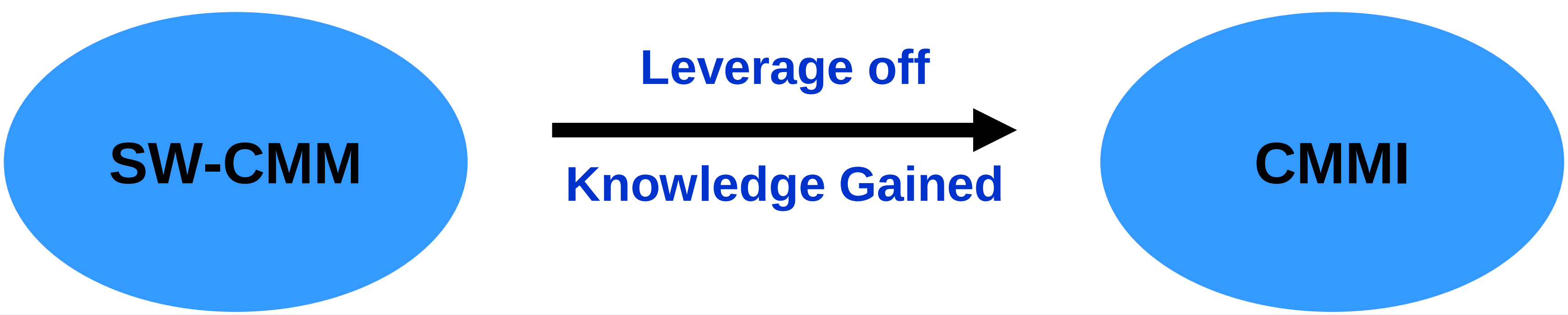
Standard **C**MMI **A**ppraisal **M**ethod for **P**rocess **I**mprovement (**SCAMPI**)

BAE SYSTEMS

– Ten member appraisal team
– The appraisal team was led by Ms. Marilyn Bush, co-author of the Software Capability Maturity Model
– Team had 4 Lead Assessors serving as members
– Team conducted 158 interviews
– Team reviewed over 800 technical and management artifacts
– Interviews with all engineering and program management organizations located spread across three states

Overview

- Current State
  - High Maturity Company
- Goal
  - Transition from SW-CMM to CMMI
  - Do not disrupt SW-CMM activities
  - Capitalize on experience obtained and infrastructure established with SW-CMMI

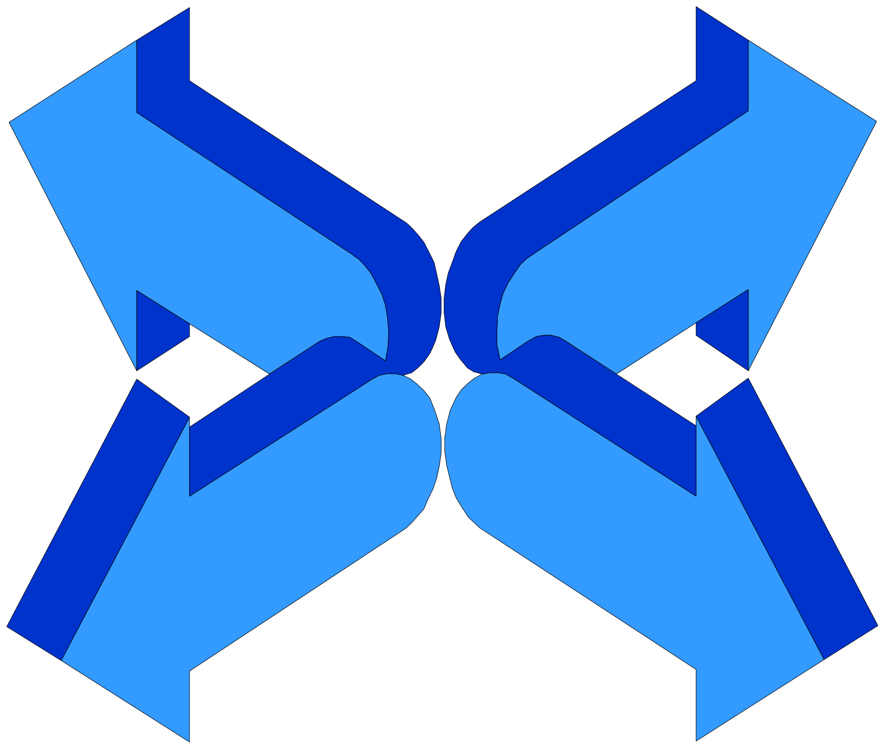


Basic Decisions

BAE SYSTEMS

Staged

Top-Down



Bottom-Up

Continuous

What Have We Learned?

- Capture How We Do Business
  - Processes should not be "wish lists"
  - Get Practitioners Involved
    - to increase the chances of compliance
- Make processes inclusive
  - Incorporate Tailoring, Links to Training Materials, Templates, Help Files
- Maintain process on Web for easy access
- Some processes already accepted by other disciplines - capitalize on that
- Process Team composed of practitioners
  - Avoid "Ivory Tower" effect
- Provide rapid response to update requests

Repeat What Works !

Transition Plan From CMM To CMMI (1)

- Pick the CMMI Model that fits your culture
  - SW-CMM is staged - company is more familiar with this type of model
  - Use CMMI Staged
- Involvement and Communication Are Key
  - Cross-Functional Teams of Software, Systems, Programs, CM, Quality, etc.
  - SEPG Members intimate with how we became a high maturity organization are involved
  - Define a Core Team representative of all stakeholders
    - Core Team member on every mini-team
    - Cross-Functional Core Team to Oversee
    - Cross-Functional Mini-Teams write processes and develop organizational assets

Transition Plan From CMM To CMMI (2)

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- Look at What Already Exists
  - Some Software Processes already adopted by other disciplines
    - Expand those processes to encompass all appropriate disciplines
  - Review Software processes for potential to integrate other disciplines
  - Where expansion is not practical, have discipline-specific sub-processes
    - Maintain existing software processes as much as possible
  - Review Other Assets in the Software OSSP
    - They serve as good indicators for what type of assets will be required for CMMI
    - Templates, training materials, databases, etc.
  - Use Existing Software Infrastructure as a model

Don't Re-Invent the Wheel

Transition Plan From CMM To CMMI (3)

BAE SYSTEMS

- Strive Towards Fully integrated process assets and infrastructure across disciplines
  - Software, Systems, Hardware, Programs
- Integrated, inter-disciplinary Process Development Teams develop processes.
  - Templates, Training Materials, Help Files
  - Linked directly into process
- Perform Gap Analysis Between CMMI and our processes
  - CMMI Compliance verified via Peer Review Tester role as well as generation/maintenance of a DOORS cross reference matrix

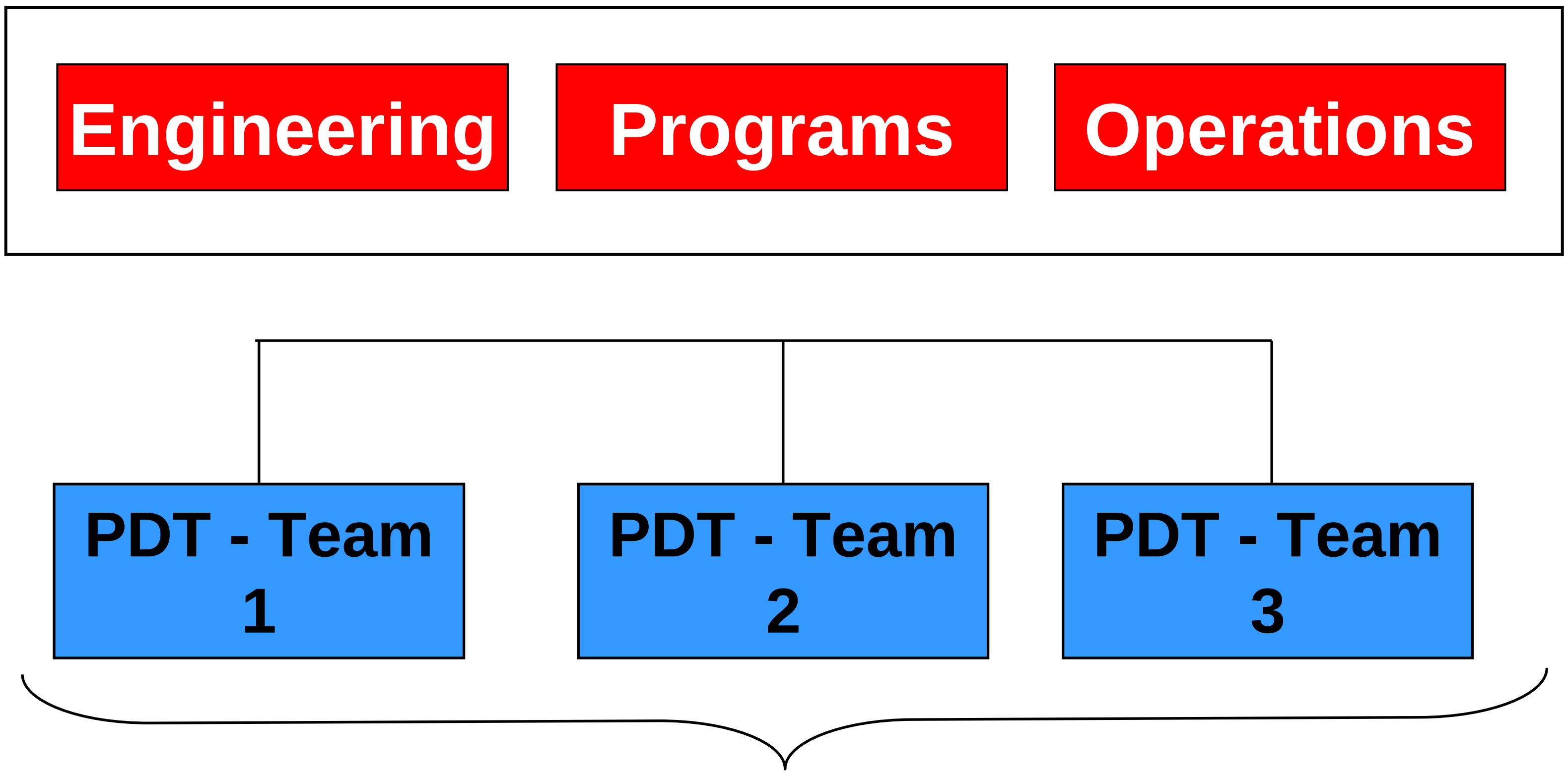
Transition Plan From CMM To CMMI (4)

BAE SYSTEMS

- A Process Steering Group (PSG) “Core Team” established to manage changes
  - Processes are integrated - must assess impact to other areas and update processes in concert
- Processes reviewed and approved by Core Team
- Processes/Process Assets on the Intranet for easy access
- Select projects for deployment based on where they are in the Life Cycle
- Process Deployment monitored and tracked against plan and corrective action taken as needed
- Process implementation monitored to determine process effectiveness and adjustments incorporated

Plan the Work and Work the Plan

CORE Team



Cross functional teams write the actual processes and supporting documentation.

Implementation Organizational Structure

BAE SYSTEMS

A ***"Core Team"*** maintains consistency and ensures that changes in one area either don't impact or other disciplines or ensures that impact is communicated and addressed. They also control the global (common) site and global (common) processes.

PSG

Core Team

SW1 **PM1**

SYS 1 **QA1**

Individual PSGs deal with issues that impact their disciplines. Representation allows for impacts to be identified. They control their site and their unique processes

SEPG

SW1 **SW2**

SW3 **SW4**

PM1 **SYS 1**

QA 1

PM PSG

PM1 **PM2**

PM3 **PM4**

SW1 **SYS1**

QA1

Sys PSG

SYS 1 **SYS2**

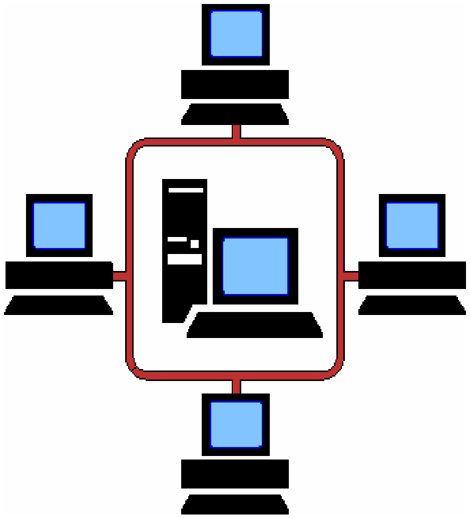
SYS3 **SYS4**

SW1 **PM1**

QA1

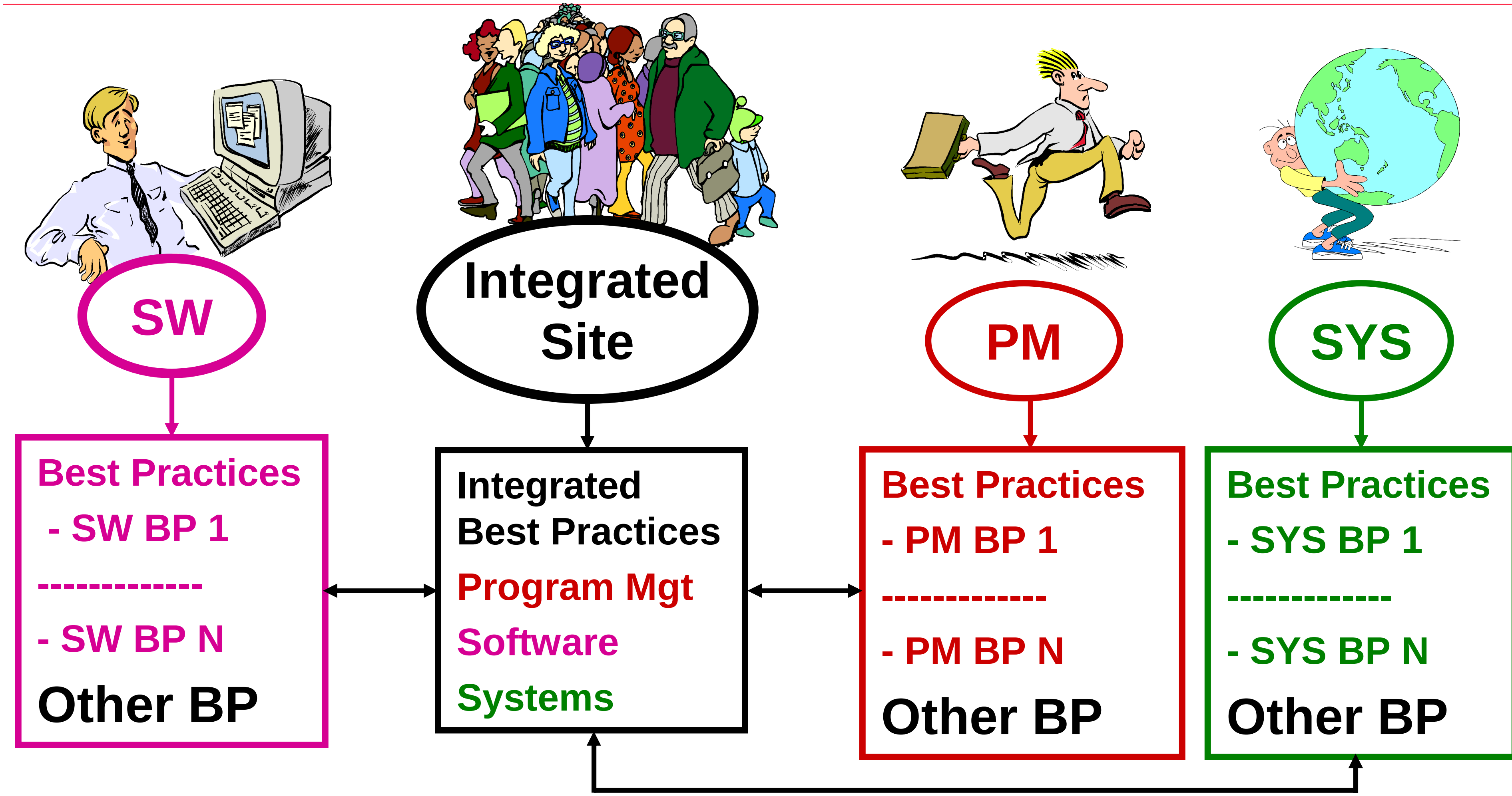
Design of Web Site

- Establish/Maintain separate discipline sites
- Establish/Maintain integrated site
- Have bi-directional links between the ‘specific” pages to the “integrated” page for an “integrated” OSSP
- Support multiple user view points
  - Users can get information by
    - Entering the site for their discipline
    - Entering through the “main” site
- Modularity allows for easy growth
  - Incorporation of other disciplines over time
  - Add new discipline Web site
  - Add links from “integrated” site to new site
  - Do not need to go to every existing site to add the new link, since all of the individual sites reference each other through the “integrated” page



Integrated Web Site Framework

BAE SYSTEMS



Multiple Entry Views Ensure You Find What You Want Regardless of Where You Start.

Data Storage Options

BAE SYSTEMS

Separate

– Each discipline has its own database with local control
  – Database can be specifically tailored for each discipline
  – Difficult to keeping in concert
– Just provides needed discipline information
– Recurring work for each discipline
– Generating global status is difficult

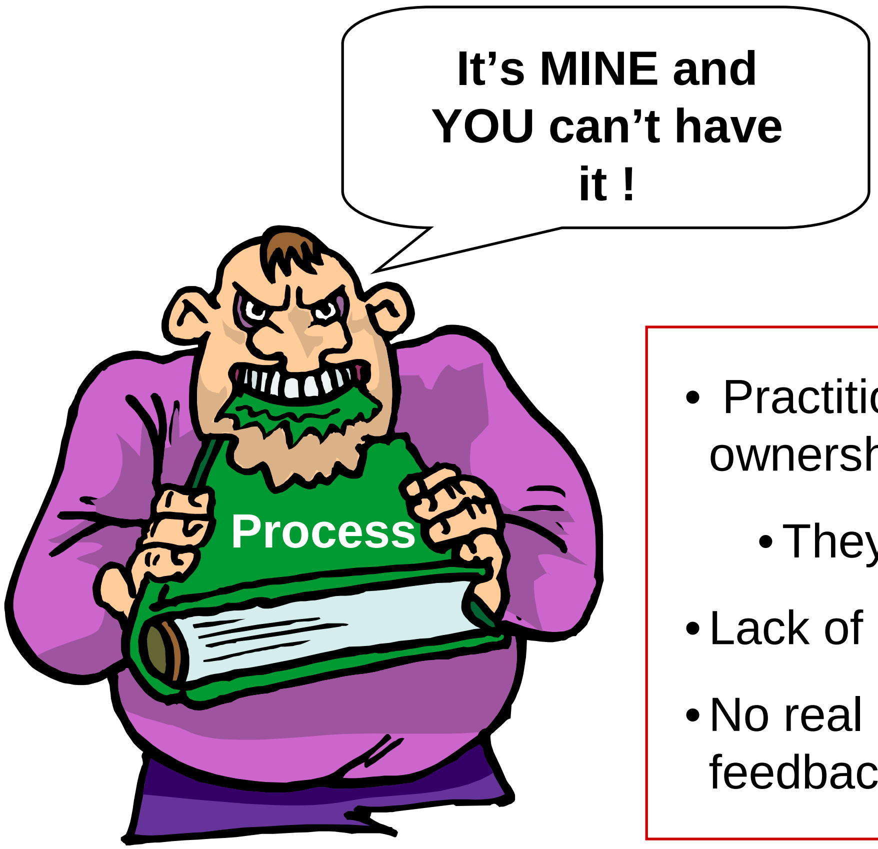
Integrated

– Single database with central control
  – Precludes discipline-specific tailoring
  – Eliminates synchronization issues
– Contains all discipline information - need to be able to sort on discipline
– No recurring cost - adding new discipline is relatively simply
– Can be set up to generate metrics per discipline and globally across all disciplines

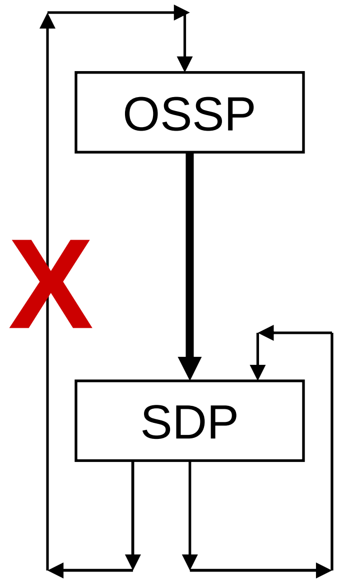
Lessons Learned

Having Process Owners

BAE SYSTEMS



- Practitioners do not feel they have ownership
  - They feel it is imposed ON them
- Lack of buy-in
- No real incentive to provide feedback



Processes Need To Be Owned By The Practitioners

Using CMM Speak

BAE SYSTEMS

When you don't know what you are talking about – it shows

Mandating Use of Inappropriate Tools

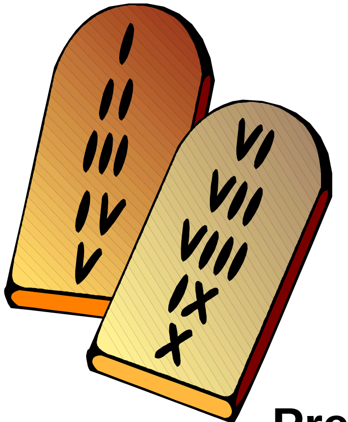
BAE SYSTEMS

There has got to be a better way!

- Imposing inappropriate tools
    - Adds no value,
    - Creates more work,
    - Discontented practitioners

The right tool for the right job

Static Processes



Premise 1: If a process is being used, the practitioner will naturally adapt it to the given situation

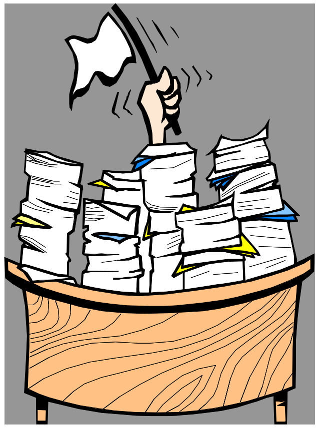
Premise 2: If the infrastructure is in place, practitioners will communicate these changes to the SEPG to make the processes better.

Conclusion: If processes are stagnant, either they are not being used or there is no path to allow change

If processes are being used, the practitioners will improve them over time

Having Processes That Are Overly Specific

- Processes cannot anticipate all possible situations
- Overly specific processes cannot be followed effectively across different projects



***"One of the challenges of Level 3 is to build processes that 'empower' the individuals doing the work without being overly rigid."* – Watts Humphrey**

Poorly Defined/Confusing Tailoring Guidelines

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- Makes it difficult/cumbersome to adapt to your project
- Complicates understanding

Tailoring guidelines should be clear and readily accessible

BAE SYSTEMS

- Overly “Hand-selecting” your best people as interviewees prevents some areas of improvement from being identified – hindering real progress
- The Assessment Team will wonder why the same people are interviewed 10 times in 20 interviews

Put your best foot forward – but remember the goal is improvement

Not Knowing Where Processes Are Or How To Change Them

How can you be FOLLOWING the process when you can't even FIND THEM ??

Not Being Able to Discuss Why You Do Certain Things

BAE SYSTEMS

Why Do You Do X?

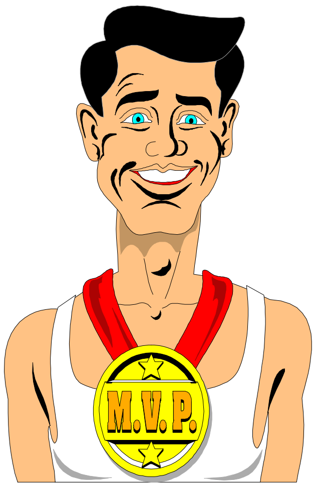
- “Because the process says so”
- “I’ve never thought about it”
- “Because it’s always been done that way”

If you don’t know why you are doing something – FIND OUT

If it is not value-added, you shouldn’t be doing it

Trying To Sound More Important Than You Really Are

BAE SYSTEMS



Inflating your importance can lead to credibility issues

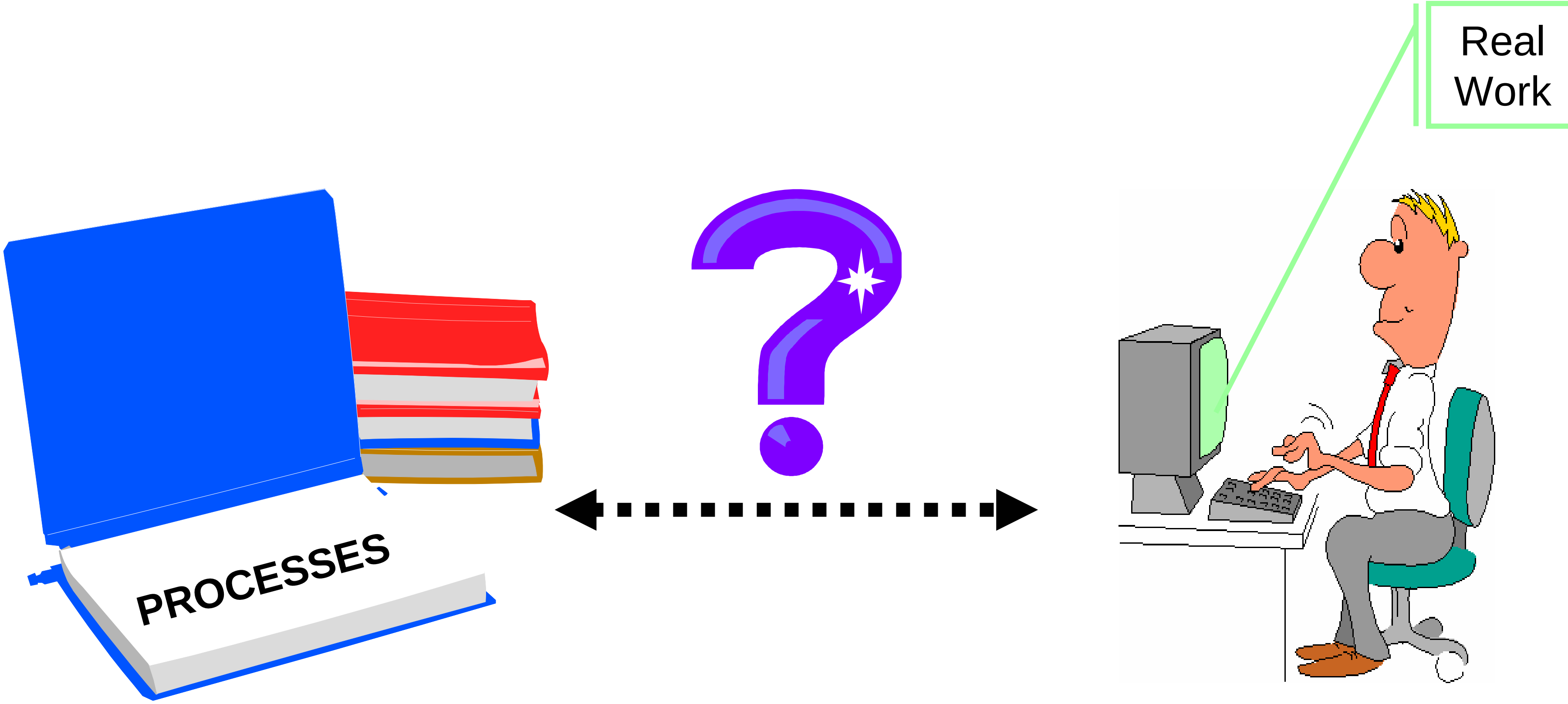
Importance Is Like Beauty - If you have to tell people, you really aren't.

Having a Poor/Ineffective Site Coordinator

BAE SYSTEMS

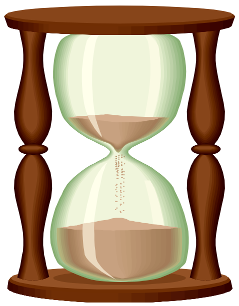
- Distracts Team from focusing on their job
- Gives the first impression of an immature company

Inconsistency Between Processes and the Way Work Is Done

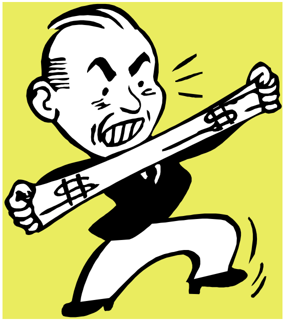


If they are inconsistent – then you are not following the process – they are only for show

Having Inadequate Resources

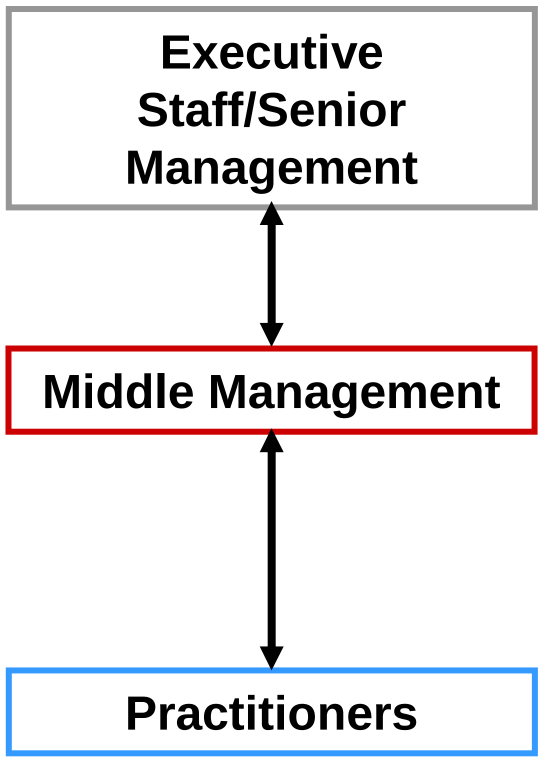


- Appropriate tools are not provided
- Not enough people allowed to work on process improvement
- Training budget always overrun
- Insufficient budget to support needed activities



You need the appropriate resources to do the job properly

Failure To Get Program Management & Middle Management Buy-In



Executive Staff/Senior Management

- **Believes in the benefit of process improvement to the organization**
- **Sponsors process improvement**

Middle Management

- **Believes process improvement is just another gimmick**
- **“Don’t bother me with this nonsense – leave me alone to do my job”**

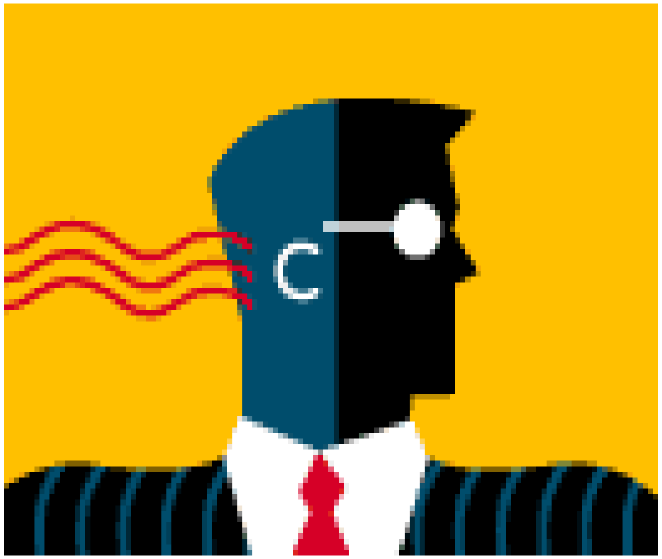
Practitioners

- **Believes that process improvement is the right way to go and will help him do his job better**

Associated Groups View Process Improvement as a "Software" Thing

BAE SYSTEMS

CMMI has NOTHING to do with MY Job



Engage Brain BEFORE Opening Mouth

Concluding Remarks

- Successful assessments are a result of many factors
  - No one item will cause you to pass or fail
  - The overall picture you present to the assessment team will determine the outcome
- No Assessment runs perfectly – but you should maximize your chance of success by avoiding obvious pitfalls
  - Say what you do and do what you say
  - Know why you do what you do
  - Be honest about what you do
- Remember: goal of an Assessment is improvement

CMMI Appraisals
The Shocking Truth Revealed during….

Lead Appraiser Family Feud !

1) Two teams
2) Each team gets a question posed to them. They get 30 seconds to answer. If they answer correctly, they get 15 points. If they miss, the question goes to the second team and they get 30 seconds to answer correctly.
3) There are two rounds and a final question where each team can answer questions from the SCAMPI B and C Handbook.

Question # 1

- How many SCAMPI v1.1 Class A appraisals were conducted from its April 2002 release through June 2005and reported to the SEI?
  - 1520
  - 868
  - 545

Question # 1

- How many SCAMPI v1.1 Class A appraisals were conducted from its April 2002 release through June 2005 and reported to the SEI?
  - 1520
  - 868 *****
  - 545

Question #2

- **What is the largest amount of Maturity Level reported?**
  - **Level 1**
  - **Level 2**
  - **Level 3**
  - **Level 4**
  - **Level 5**

Question #2

- What is the largest amount of Maturity Level reported?
  - Level 1 (3.5%)
  - Level 2 (34.1%)
  - Level 3 (29.7%)
  - Level 4 (4%)
  - Level 5 (19.2%)

Question # 3

- What is the largest category of reporting organizations for a SCAMPI Class A?
  - Commercial/In-house
  - Contractor for Military/Government
  - Military/Government Agency

Question # 3

- What is the largest category of reporting organizations for a SCAMPI Class A?
  - Commercial/In-house (63.4%)
  - Contractor for Military/Government (31.7%)
  - Military/Government Agency (4.9%)

Question # 4

- What is the largest organization type that reported having done SCAMPI Class As?
  - Manufacturing
  - Defense
  - Services
  - Finance, Insurance and Real Estate

Question # 4

- **What is the largest organization type that reported having done SCAMPI Class As?**
  - **Manufacturing (25.8%)**
  - **Defense (12%)**
  - **Services (52.1%)**
  - **Finance, Insurance and Real Estate (6.7%)**

Question # 5

- What is the largest number by size of the organization reported?
  - 1-100
  - 101-200
  - 201-2000+

Question # 5

- **What is the largest number by size of the organization reported?**
  - **1-100 (40.5%)**
  - **101-200 (18.7%)**
  - **201-2000+ (40.9%)**

Question # 6

- What new country just reported for the first time having had a SCAMPI A?
  - Turkey
  - South Africa
  - Belarus
  - Netherlands

Question # 6

- What new country just reported for the first time having had a SCAMPI A?
  - Turkey ****
  - South Africa
  - Belarus
  - Netherlands

Round 2: Questions on the SCAMPI B/C Handbook

- The Handbook is an essential tool for performing SCAMPI B and C Appraisals.

Question # 1

- What is the Optional ‘Fidelity’ Scale for a SCAMPI C ?

Question # 1

- What is the Optional ‘Fidelity’ Scale for a SCAMPI C ?
  - Low, Medium, High and Out of Scope

Question # 2

- What are the 3 primary phases of a SCAMPI Appraisal?

Question # 2

- What are the 3 primary phases of a SCAMPI Appraisal?
  - Plan and Prepare
  - Conduct
  - Report Results

Question # 3

- True or False, SCAMPI C does not require the use of a team.

Question # 3

- True or False, SCAMPI C does not require the use of a team.
  - True, unless you are Judah, and consider yourself a team of one.

Question # 4

- True or False, The minimum acceptable team size for SCAMPI B is 4 people.

Question # 4

- True or False, The minimum acceptable team size for SCAMPI B is 4 people.
  - False, the minimum team size for a SCAMPI B is 2 people

Question # 5

- True or False: For SCAMPI B and C, every interview can be conducted by use of teleconference (if interviews are used)

Question # 5

- True or False: For SCAMPI B and C, every interview can be conducted by use of teleconference (if interviews are used)
  - True “ For SCAMPI B and C, there is no limitation on the use of technology to conduct interviews. Every interview can be conducted through use of teleconference (or video teleconference) technology.”

Question # 6

- True or False, For a SCAMPI C, affirmations if used, do not have to be corroborated.

Question # 6

- True or False, For a SCAMPI C, affirmations if used, do not have to be corroborated.
  - True. the use of a single data source is all that is needed for the SCAMPI C method.”

Question # 7

- True or False: All team members of SCAMPI B and SCAMPI C must complete the Intro to CMMI (SEI Official course) .

Question # 7

- True or False: All team members of SCAMPI B and SCAMPI C must complete the Intro to CMMI (SEI Official_course) .
  - True. “To serve as a team member on a SCAMPI, one must successfully complete the Introduction to CMMI. This course must be taught by an SEI-Authorized instructor, working on behalf of an SEI Partner, in order to be accepted.”

Question # 8

- What is the Required Practice Characterization Scale for a SCAMPI B?
- Bonus question: What other two ‘different’ characterizations are allowed?

Question # 8

- **What is the Required Practice Characterization Scale for a SCAMPI B?**
  - **Practice Characterization for SCAMPI B are “Red, Yellow, Green”**
  - **Bonus: Not yet and Out of Scope**

Question # 9

- True of False: In a SCAMPI B or C there shall be no characterization assigned to process areas, or to goals within a process area. The only model element that can have characterizations is a specific or generic practice.

Question # 9

- **True of False: In a SCAMPI B or C there shall be no characterization assigned to process areas, or to goals within a process area. The only model element that can have characterizations is a specific or generic practice.**
  - **True: Section 2.5 of the Handbook describes this requirement.**

Question # 10

- True or False: An oral presentation is sufficient for SCAMPI B and C appraisal results as a lasting record of the outputs.

Question # 10

- True or False: An oral presentation is sufficient for SCAMPI B and C appraisal results as a lasting record of the outputs.
  - False: Every SCAMPI B and C appraisal must have documented results that represent a lasting record of the outputs. An oral presentation alone is not sufficient. “If it’s not documented, it doesn’t exist”.

Final Double Jeopardy

- Each team can bid all or none of their score.
- The Category is: Generate Appraisal Record.

Appraisal Record Contents

- Name 4 of the 7 (SCAMPI B/C) items that the appraisal record must contain.

- You have 2 minutes………

And the Answer Is!

- dates of the appraisal
- appraisal input
- identification of the appraisal method used (including tailoring)
- findings, including strength and/or weakness statements
- practice characterizations (if generated)
- other characterizations of data or attributes of practices or projects, generated during the appraisal (if any)
- appraisal disclosure statement
  - Page 72, Section 3.4 of the SCAMPI B and C Handbook.

And the Winner is……

- The owners of Borders Gift Certificates!

Lead Appraisers Gone Wild!

Or How NOT to Lead an Appraisal!

Background on this topic, or why I want all my peers mad at me.

- I have performed SCAMPI As since 2000. Have performed over 15.
- Have performed SCAMPI Bs about 10
- Have performed SCAMPI Cs about 20
- Also am a candidate LA Observer.
- I see a lot of bad habits and misunderstandings of the method during appraisals.
- Some of the following are examples of MDD violations, some are just my pet peeves.

Does anyone out there read the MDD?

- The Method Description Document which describes the Standard CMMI Appraisal Method for Process Improvement is designed to provide benchmark quality ratings relative to the CMMI.
- The MDD describes the requirements, activities, and practices associated with each of the processes that compose the SCAMPI method. Precise listing of required practices, parameters and variation limits as well as optional practices and guidance for enacting the method, are covered.

Read the MDD

- Sometimes as a LA you have to read!
- We know that if you don’t know where you are, a map won’t help, BUT,
- you can get the MDD off the SEI’s website at …/pub/documents/01.reports/pdf/1hb001.pdf
- LAs, this is YOUR BIBLE!!

Understand the Appraisal Plan MDD Section 1.2

- As in: 'Yes, you have to have one' (1.2.6)
- And 'Yes, the sponsor has to approve/sign it' (1.2.6)
- And 'Yes, you have to identify your needed resources. (1.2.2) This is nice to do BEFORE the on-site period.
- When I ask to see the schedule, don't say "We are just going to see who's here this week to interview" (logistics 1.2.4)

Identify Needed Resources MDD 1.2.2

- When I ask for proof of team training and training of the team, don't say "We don't need no stinking Intro to CMMI class" (1.3).
- When I ask if the team as individuals and as a whole meet the minimum criteria, don't give me the blank stare then ask me how many lbs of Godiva chocolate I want (1.3.2)

Plan and Manage Logistics MDD 1.2.4

- Scheduling!
  - Please DO NOT kill your appraisal team and make the work days longer than 9 hours. They will not like you. It also leads to bad habits!
  - Please DO NOT have 16 interviews, all back to back in 4 days. Leave at least 1.5 hours between interviews for mini-team consolidation.

Plan and Manage Logistics MDD 1.2.4

- If you want the team to be together ALL day, have at least water available for them. If you want them to work through meals, have meals brought in. Ask if any members have specific dietary needs.

Identify Team Leader
MDD 1.3.1

- Select an authorized SCAMPI Lead Appraiser to serve as the appraisal team leader.
- Verify the qualifications of the appraisal team leader (experience, knowledge, and skills).

Identify Team Leader
MDD 1.3.1

- The requirements for a Team Leader are outlined in the SEI Lead Appraiser program.
- There can be only one official appraisal team leader on any given appraisal.

Obtain and Analyze Initial Objective Evidence MDD 1.4

- Verification Versus Discovery

Gather high-leverage objective evidence. The amount of initial objective evidence provided by the organization will determine the proportion of evidence that must be discovered (versus verified) during the appraisal. Maximizing time spent in verification, versus discovery, is a key performance objective for the appraisal process.

Obtain and Analyze Objective Evidence MDD 1.4

– The effort required to conduct a SCAMPI appraisal is a direct function of the amount of data available to the team at the beginning of the process. Before the appraisal outputs can be created, the team will need to verify objective evidence for each instantiation of each practice within the scope of the appraisal.

– Leave at least 2-3 days for Analyzing Objective Evidence. Do not do this AFTER interviews start.

Prepare Participants 1.4.1

- Members of the organization who participate in the appraisal MUST be informed of their role, and the expectations the sponsor and appraisal team have.
- This is typically accomplished through a briefing where the appraisal team leader provides an overview of the appraisal process, purpose, and objectives
- Many time I hear ‘I can’t make the Opening Meeting mandatory, the organization won’t come anyway’, or ‘So and so is on TDY, or they have a nosebleed today, or whatever’.

Prepare Participants 1.4.1

- Not making this opening meeting mandatory makes you, or someone on the team, explain over and over again at the beginning of each interview to the interviewees, why they are there.

Perform Readiness Review MDD 1.5

- Determine whether the objective evidence for each process instance is adequate to proceed with the appraisal as planned.
- Review the feasibility of the appraisal plan in light of the inventory of objective evidence available.
- At least one readiness review MUST be conducted prior to assembling the team on site for data collection.
- Again, DO NOT do this after INTERVIEWS start.

Perform Readiness Review MDD 1.5

- At least one readiness review MUST be conducted prior to assembling the team on site for data collection
- Again, DO NOT do this after INTERVIEWS start.
- Don't make me call this guy →

Examine Objective Evidence from Interviews MDD 2.1.4

- This is not your old CBA-IPI Methodology. Stop needless interviewing! Don't let this happen to you ->

- Obtain face-to-face affirmations for (1) at least one instantiation for each model practice in the scope of the appraisal, or (2) at least 50% of the practices corresponding to each specific and generic goal for each instantiation.

Examine Objective Evidence from Interviews MDD 2.1.4

- And speaking of interviews. Do not let your appraisal team members fall asleep during the interviews.
- Make sure that you introduce all members of the appraisal team to the interviewees.

Examine Objective Evidence from Interviews MDD 2.1.4

- Also, do not ask the same questions that have already been asked. Pay attention, during all questions. “These notes must cover all areas investigated during the interview, and are not limited to the PAs assigned to the individual team member (i.e., everybody takes notes on everything).” (2.3.1)
- Do NOT ask a question, and then when the interviewee is answering, not write down what they are saying…. argh!

Take/Review/Tag Notes MDD 2.3.1

- And speaking of NOT taking notes…. “Every team member present must take notes during interviews and presentations.”
- Just because during an interview, the questions being asked do not pertain to YOUR PA, does not mean you can decide to go home for the day.

Take/Review/Tag Notes MDD 2.3.1

- All team members actively take notes during all data-gathering sessions. “The purpose is to record, verbatim, what the information source reveals about the implementation of practices in the project or organization.”
- In other words, do not rely on memory when you are tagging your notes. Take good notes during the interviews!

Remember,

- Make friends with those you are interviewing as well as those on your team.

Some Closing Notes

- Above all, be the LA everyone wants to have come back!

Last But Not Least!

- Have fun!

CMMI v1.1 for a Service-Oriented Organization

By Steve Hall, Jeff Ricketts, Diane Simpson

16 November 2005

Overview

This presentation will describe how CMMI v1.1 was applied to Raytheon Company's Information Technology and Scientific Services (ITSS), a service-oriented company, located in Pasadena, California so that the SCAMPI could be used to assess the process maturity level of the organization.

- **Key components to the success of any endeavor**
  - **Desire – to have a longing for along with a strong intention or aim**
  - **Drive – a strong systematic group effort**
  - **Determination – the power or habit of deciding definitively and firmly**

These were demonstrated by the ITSS organization

Overview

- Prelude to the Appraisal
- The Appraisals
  - The Plan for the Appraisal Approach
  - Goal of the Appraisal Team
- The Process of Team Building
  - Appraisal Team Composition
  - Synergy
- Understanding the Business & Applying the Model and Appraisal Method
  - The interpretations that were established and the balance that is required for keeping the “spirit” of the model,
  - Maintaining the integrity of the appraisal,
- Summary

Raytheon Pasadena – SDSIO Contract

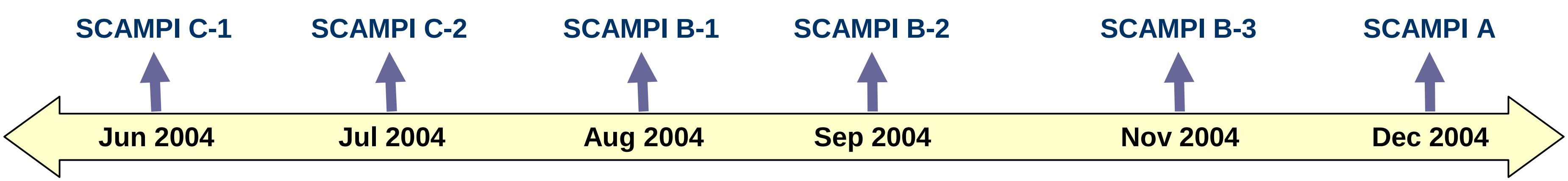
- Program information
  - Work-Order-Based Service Contract
    - **Focus is on Delivering Defined Services and Products**
    - **End-user of products and services is the customer**
    - **Raytheon staff frequently injected into projects lead by customer working along side of other contractors and customers**
  - Organized into 6 departments (web services, GPS applications, IT, Science Systems, Ocean Data Center, and Remote Sensing)
  - Number of Staff: 144
  - Award: September 1998
  - Type: CPAF/CPFF - Contract Work Orders (CWO)
  - Period of Performance:
    - Completed 5 year Base: (Sept/03)
    - Executing 3+2 option years
  - Scope: 100+ work orders – 63 active

History of Process Improvement at ITSS

- Grass-roots effort from the start -1999
  - Special Interest Group (SIG) formed for Process Improvement
    - The SIG has helped the customer with its own process improvement initiative
- R6s Introduced as a process improvement framework at Pasadena – 2000
- Evolutionary Process starting with CMM – 2001 through 2002
  - First attempts were top-down
  - Not funded
  - Intellectual breakthrough
    - Introduction of CMMI
    - Bottom-up as the most effective approach
- CMMI Training and formation of a mentoring relationship with a high maturity Raytheon site – 2003
- CMMI steering committee formed with customer and outside Raytheon support – 2003 – SCAMPI planning begins
- Customer sets goal to achieve CMMI L2 rating by 2005 and L3 by 2007 – 2003
  - Navigation and Mission Design Section achieved CMMI L2 (September 24, 2004)

The Appraisals

- **The Goal**
  - Appraise the maturity of Raytheon Company's Information Technology and Scientific Services (ITSS) in Pasadena, California.
  - Ensure the integrity of the appraisal process and outcome
- **The Plan for the Appraisal**
  - Conduct a series of appraisals where process areas reviewed align with the organization's process deployment schedule.
    - **Each appraisal event ranged in duration from 3 to 9 days**
  - Use the SCAMPI A to determine the process maturity level of the organization



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The Appraisals

- **The Approach**
  - The intent of the SCAMPI C events was to understand the business model employed by the organization
    - These events were primarily used as information gathering through interview sessions by the team with the practitioners
    - In the effort to understand the business model, the appraisal team sought to find answers to such questions as:
      - What is the product and when does sell-off occur?
      - What is the management structure that is in place?
      - Who plans, assigns and monitors the work?
      - What are the technical requirements?
      - What is verified; what is validated and when?
      - What are the work products and how are they controlled?
    - In between information gathering sessions within each event, the team explored possible parallels between the business model and the CMMI
    - As parallels between the business model and the CMMI were identified and agreed upon, they were recorded as the "Group Memory"
    - Feedback was also provided to the organization, primarily in the form of recommendations and requests for information
  - In between SCAMPI C events, process and templates evolved to incorporate feedback from the appraisal team

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The Appraisals

- **The Approach cont.**
  - **The intent of the SCAMPI B events was to provide feedback to the organization based on their business model and its mapping to the CMMI**
    - **Through the conclusions drawn by the appraisal team and other activities undertaken by the organization prior to the first SCAMPI B event, the organization concluded their business model was primarily that of a service organization**
    - **The team appraised the evidence provided according to the understandings established for the service business model to the work products created to deliver the service**
    - **The record of the team's agreements on model interpretations was updated to reflect additional understandings which were identified during each event**
    - **Rules of coverage for contributions to the organizational repository were established**
    - **Weaknesses were identified for the organization to address.**
  - **In between SCAMPI B events, process and templates continued to evolve to incorporate feedback from the appraisal team**

The Appraisals

- **The Approach cont.**
  - The intent of the SCAMPI A Event was to appraise the process maturity level of the organization and provide feedback on strengths and weaknesses
    - Direct evidence in the form of work products created or employed during the course of delivering the service was appraised in accordance with the established interpretations of the model
      - Established rules of coverage for contributions to the Organizational repository were applied
    - Interviews were used to satisfy the SCAMPI requirement for indirect evidence; Interview coverage included 100% of the projects and organization
    - Strengths and weakness were identified
    - A rating was determined

The Process of Team Building

- Appraisal Team Composition
  - Team composition underwent a number of changes, including
    - Planned "tag team members"
    - Dropouts and replacements
  - Changes to the team make-up occurred in 2 slots of the 9-member team
  - Overall, the impact of the changes to team membership was not significant and from one perspective had an added benefit
    - The impact was lessened by the fact that the changes occurred between events
    - The added benefit was that each change presented an opportunity for the team to validate its interpretations of the model as applied to the service business model
  - The final team composition included internal (ITSS) employees, external (Raytheon Fullerton employees) and independent contractors
    - 3 internal (ITSS Pasadena)
    - 3 external (Raytheon Fullerton)
    - 2 external (non-Raytheon independent contractors)
    - Lead appraiser

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The Process of Team Building

- Synergy
  - 5 of the external members had previous experience as appraisal team members
  - 1 internal member and 2 external members came from organizations with high maturity levels
  - Having an appraisal team with this kind of experience resulted in:
    - Feedback included examples of how organizational weaknesses could be addressed rather than just listing the weaknesses
      - Many of the examples provided were implemented by the organization
    - The teams ability to “connect the dots” in real time to identify the available evidence for satisfying some of the model’s requirements
    - Feedback identifying available evidence that would satisfy multiple PAs under review

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Understanding the Business and Applying the Model

- The most important thing we used in getting a handle on applying CMMI to a service based organization was to understand the life-cycle of a typical service contract

- Once the life cycle was defined, everything fell into place…

Life Cycle of a Services “Type” Contract Work Order (CWO)

Phase	1					2			3							4			5
Role	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
Customer	Develop new work	Develop SOW, discuss cost (informal)	Send SOW to CTM										Approve or disapprove WCP and Pricing	If WCP & Pricing are not approved go to column 8					
Raytheon Department Manager	Develop new work	Develop SOW, discuss cost (informal)					Assign CWO manager and lead to project			Sign WCP, Pricing						Update department WAD			
Raytheon CWO Manager								Creates WCP		Sign WCP, Pricing						Create Charge Numbers	Schedule (in PMERS)		
Raytheon Project Lead	Develop new work	Develop SOW, discuss cost (informal)																Assign Team	
Project Team Member	Develop new work	Develop SOW, discuss cost (informal)																	Start work
Customer CTM				Verifies SOW is within SDSIO contract scope	If not within scope, send back to customer								If WCP and Pricing are not approved, Raytheon CWO Manager re-does						
Raytheon PM						Assign new work to Department Manager				Sign WCP, Pricing									
Customer Contracts					If SOW OK, send to Raytheon contracts							Send WCP & Pricing to Customer			Issue CWO#				
Raytheon Contracts						Forward SOW to Department Manager				Sign WCP, Pricing	Send WCP and Pricing to Customer Contracts								
Raytheon Finance									Pricing	Sign WCP, Pricing						Create Charge Numbers	Schedule (in PMERS)		
Model Map	RD, REQM	RD, REQM	RD, REQM	RD, REQM	RD, REQM	PI	PI	PP	PI, PP	VER, VAL, PI, RD, REQM	VER, VAL	VER, VAL, PI	VER, VAL, PI	VER, VAL, PI	PI	PI	PI, PP	PI, TS	TS, IPM

Support Process Areas

- PPQA is performed at the Org level while PMC, M&A, and RskM are performed at the project level, as expected. These processes are maintained throughout the projects life cycle like any other type of contract with status rolled up and analyzed at the Org level.

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Planning Process Areas

- **Project Planning (PP) and Integrated Project Management (IPM) for a service contract is performed <u>after</u> the contract award and maintained throughout the projects life cycle with status rolled up and reviewed at the Org level**

Org Process Areas

- As expected, Organizational Training (OT), Organizational Process Focus (OPF), and Organizational Process Definition (OPD) are performed at the Org level (EPG and HR)
- In addition Supplier Agreement Management (SAM) and Configuration Management (CM) are also performed at the Org level for all contracts

Engineering Process Areas

- As we anticipated, this is the area that created the greatest amount of “mind bending” in applying CMMI to a service organization

- Lets look at the interpretation of these PAs…

Requirements Development (RD)

- What are requirements to a service organization other than “Give me 3 people for 6 months”??
- What was realized is the requirements should focus on the services they provide:
  - RTSC Pasadena Operations shall provide effective management for the project.
  - RTSC Pasadena Operations shall provide adequate staffing for the project.
  - RTSC Pasadena Operations shall provide sufficient facilities and equipment for the project.
  - RTSC Pasadena Operations shall manage project expenses as specified in the project Work Control Plan.
  - RTSC Pasadena Operations shall provide adequate organizational support for the project.

Requirements Management (RM)

- **So..If you have a set of requirements that generally don’t change how do you manage them??**
- **Well, what you manage are the derived requirements unique to the different projects, recorded in the project’s *Work Control Plan (WCP)*.**
  - **Derived from the customer’s (JPL) SOW**
  - **WCP common template facilitates this derivation**
    - **This facilitates consistency with requirements and project plans’ & work products**
- **The requirements in the Work Control Plan are mapped to the Organization’s requirements providing the bi-directional traceability**
- **Requirements are managed using a change control system**

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Technical Solution (TS)

- How would you apply a Technical Solution to the need for providing people to perform a task??
  - The WCP is also used to identify customer needs to provide the service
    - facilities
    - finances
    - management
    - support
  - DAR is used identify appropriate personnel
    - ➢ Do they need a web designer or a rocket scientist?
    - ➢ How long will they be needed?
    - DAR is also used to select an alternate
      - ➢ What if your primary candidate gets hit by lightning?

Product Integration (PI)

- The principal product supplied to our customer is:
  - Staff
  - Supported by
    - Management, IT, Facilities, tools, training, and process infrastructure
- Product Integration is the assembly of the service solution
  - cost
  - WCP (designated facilities, support/tools, management and staff)
- Management team and customer review the integrated solution and provides feedback to the CWO manager.

Verification (VER)

- The verification environment – Described in task diary
- Verification procedures – The Project Development Plan (PDP) describes the "exit criteria" associated with each task
- Peer reviews – The Work Control Plan (WCP) and PDP are peer reviewed using accepted methods and collection of statistics
- Verification of selected work products
  - The Raytheon supervisor managing the Contract Work Order (CWO) goes through the task diary and verifies each task is IMPLEMENTED according to established exit criteria
  - When this verification is complete, the customer is notified signaling the beginning of the validation phase

Validation (VAL)

Validation is the customer formally acknowledging that a task has been implemented to their satisfaction. Project lead marks task as COMPLETE in the diary when this customer acknowledgement has been received and documents when and how this acknowledgement was obtained

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Summary

- **CMMI V1.1 can be applied to a Service Organization**
  - The interpretations that were established and the balance that was required to keep the "spirit" of the model
  - The integrity of the appraisal was maintained
  - The benefit of knowledge sharing from a more mature organization with it's "sister organization"
  - The development of a set of enablers by Raytheon ITSS that can be applied to other Raytheon service organizations and increasing the ROI for this exercise
  - Benefits to the organization as its processes continue to improve

Building a Measurement Information Model in Support of Diverse Organizations

Dr. Richard Hayden
pragma Systems Corporation

processMax
THE PROCESS SOLUTION

Presentation Overview

- About pragma Systems and processMax
- CMMI Measurement requirements & challenges
- ISO 15939 Measurement Information Model
- Implementation Approach
- Summary

- Founded 1990
- One of the first organizations licensed by SEI to perform assessments
- Software Process Improvement consulting and assessments for seven years
- First release of processMax in 1998

processMax
THE PROCESS SOLUTION

Some of Our Customers

Government	Government Contractor	Commercial
U.S. Navy	Northrop Grumman	ADP
U.S. Army	General Dynamics	Bosch
Department of Labor	Mantech	United Healthcare
Veterans Benefits Administration	Teledyne Brown	GTECH
National Security Agency	Dynamics Research	Intuit
National Institutes of Health	L3 Communications	Chicago Mercantile Exchange

More than 50 successful independent assessments or appraisals

What is processMax?

Defined Processes

. . . includes all policies, procedures, guidelines, criteria, templates, and forms in role-based, step-by-step instructions, ready for use.

. . . fully compliant with the Capability Maturity Model® for Software (SW-CMM) or Capability Maturity Model Integration (CMMI).

Project Repository

. . . total document management with version control, change control, and process history.

Integrated Workflow

. . . automatic e-mail notification of tasking and actions

processMax
Organization–Project Structure

Organizational Portal

Organizational Programs Roles
Templates
Guidelines
Criteria, Methods, Forms
Plans, Reports, Data, Memos
Organizational Training Materials
Organizational Training Records
Organizational Library of Project Examples
Organizational Library of Project Data
Organizational Policies

Measurement Repository

Organization's Standard Software Project Process
- Project Management Roles
- Project Technical Roles
- Templates
- Guidelines
- Criteria
- Methods
- Forms

Instantiate **Organization's Standard Software Project Process** for software development or maintenance projects

Formal Feedback Mechanisms

Project 1 Portal

Project 1's personnel use this website

. . .

Project N Portal

Project N's personnel use this website

Measurement requirements of SW-CMM vs. CMMI

SW-CMM:

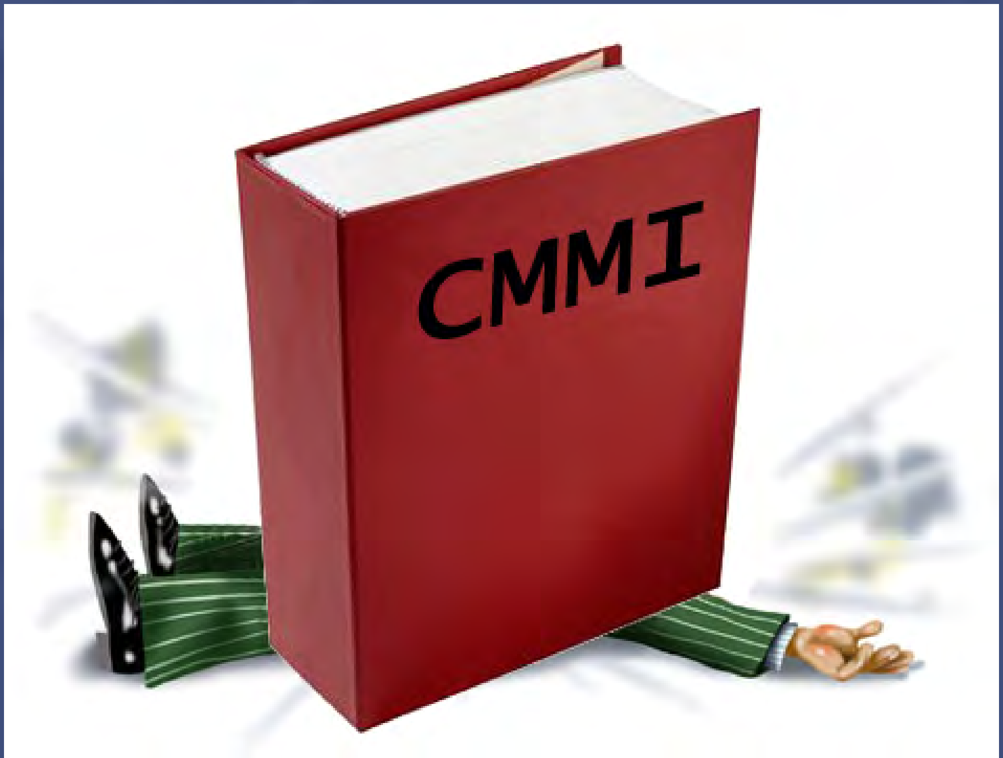
- Measurement is decentralized and focused on satisfying individual KPAs

CMMI:

- Focus on measurement – “no longer in the fine print”
- Early emphasis at Maturity level 2 – M&A Process Area
- Other process areas (OPD, OPP, OPM, CAR, OID) have significant measurement content
- Also Generic Practices 2.8, 3.2, 4.1, 4.2, 5.1, 5.2

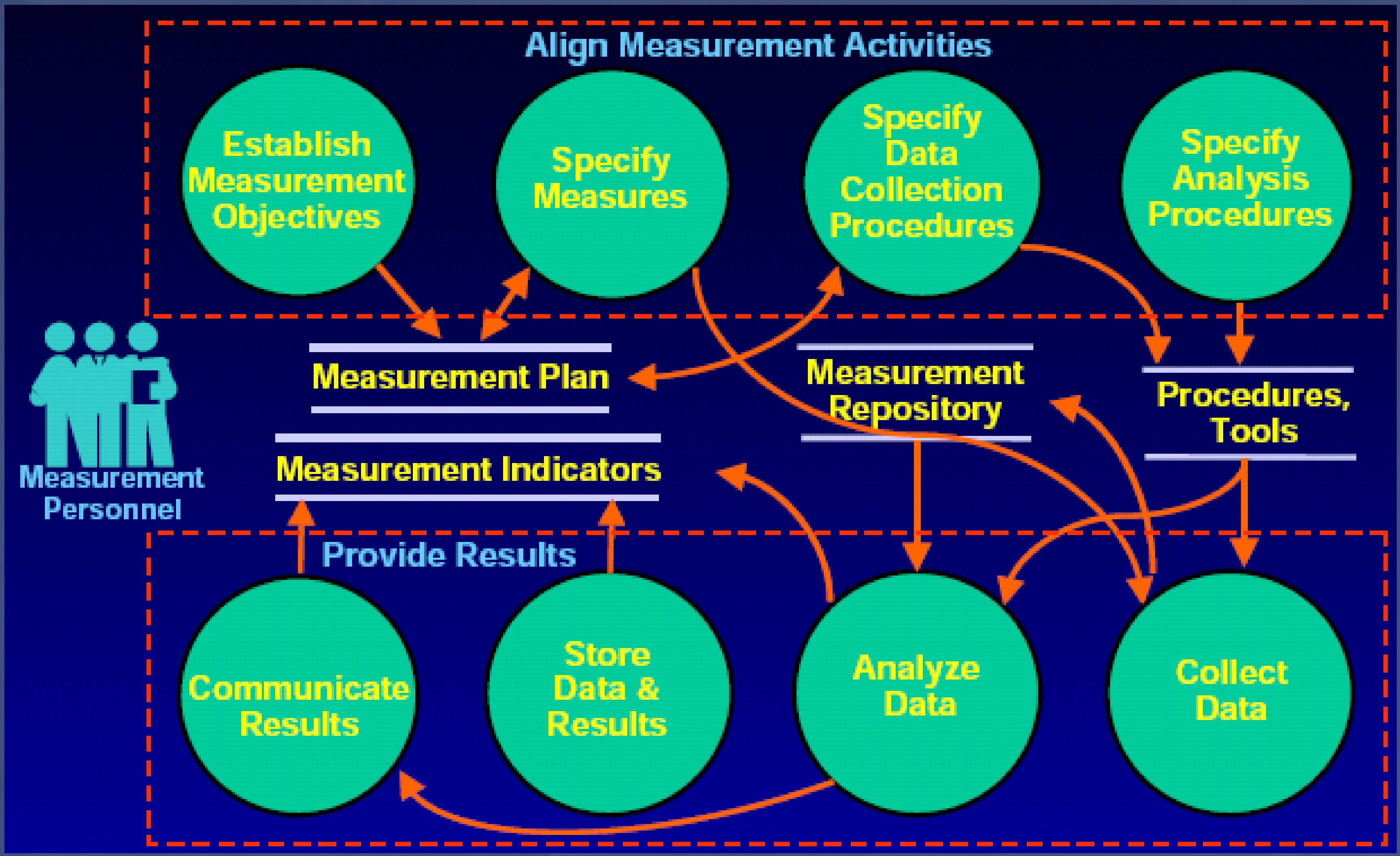
The Challenge

CMMI: ponderous and complex for appraisers, engineers, and managers



There are approximately 200 detailed measure-related requirements for Maturity Level 3 and another 60 for Maturity Levels 4 & 5.

Measurement & Analysis
(a Level 2 Process Area)

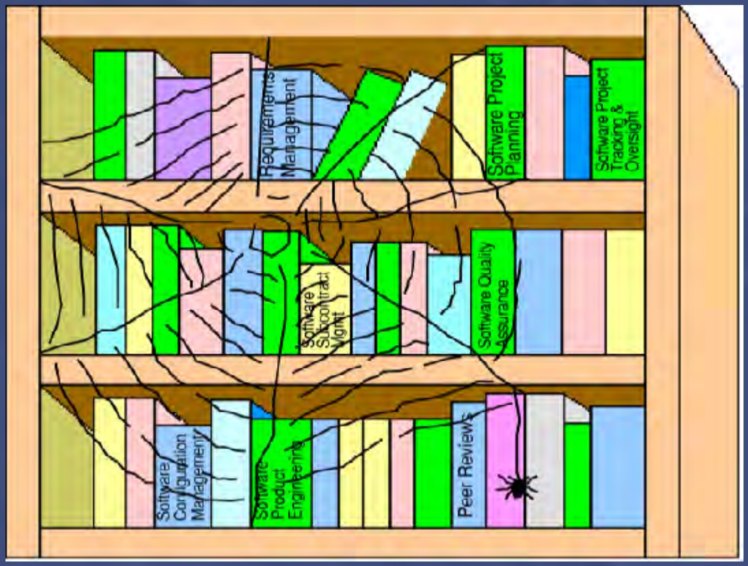


Challenges

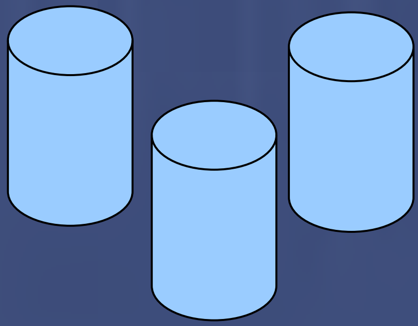
- Collecting data is very onerous and error prone
- CMMI more explicitly requires measurements, especially of process-oriented activities
- How to support large number of measures implied by the CMMI in a consistent way
- Diversity of target organizations – project types and size
- Need for customizability
- Measurement collection must be integrated with day-to-day work

Typical Situation

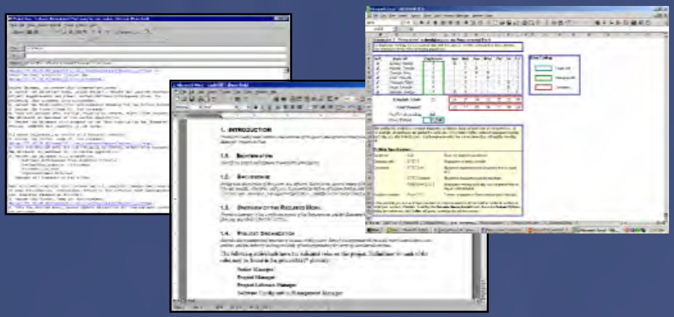
Process



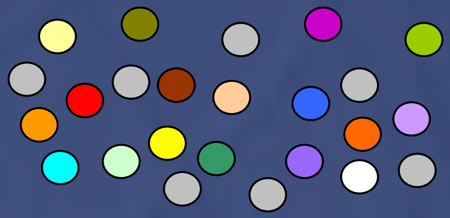
Data



Tools



Measures

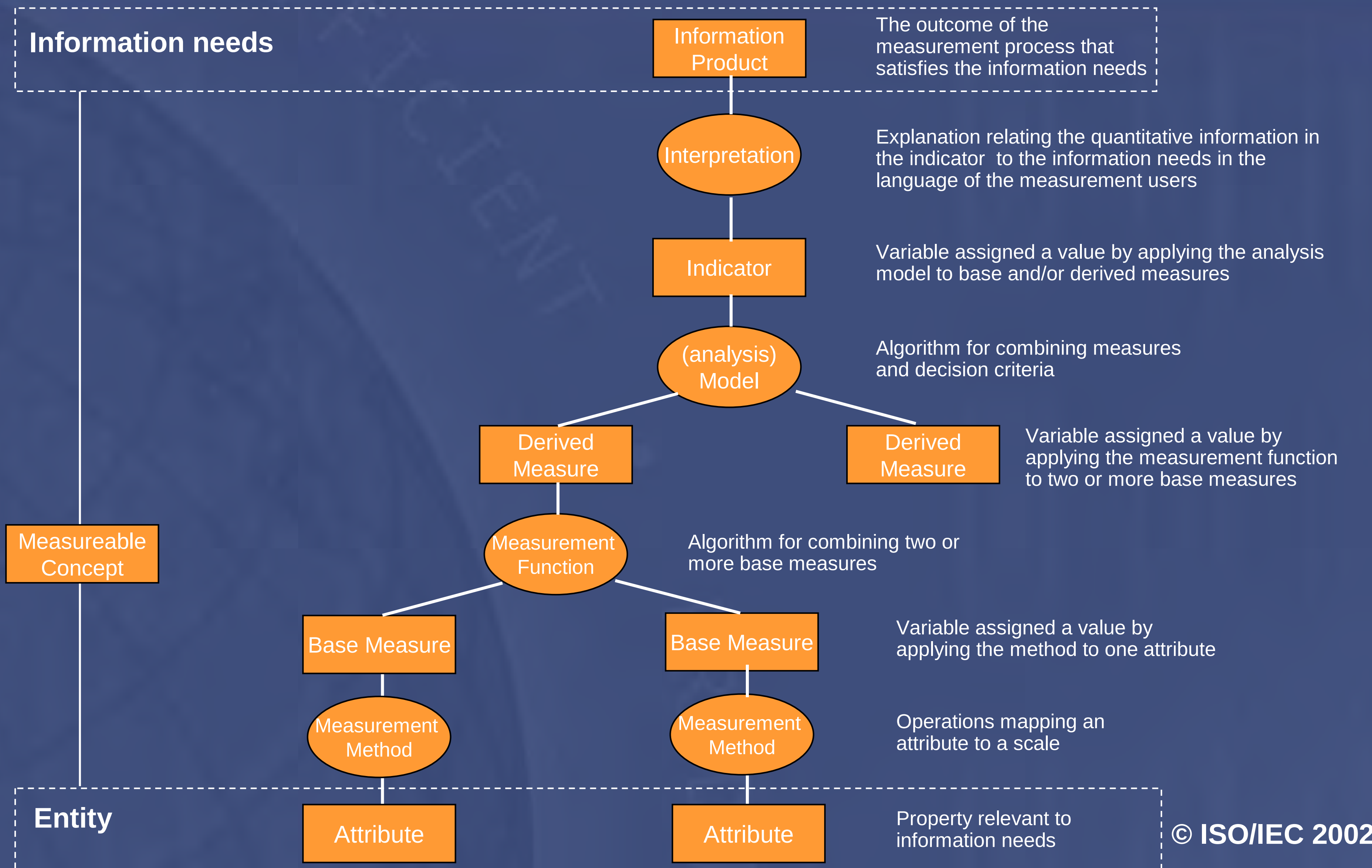


processMax
THE PROCESS SOLUTION

Why ISO IEC 15939 Standard?

- Robust ISO model meets CMMI requirements and ensures consistency across Process Areas.
- ISO Measurement Information Model (MIM) provides “structure linking information needs to the relevant entities and attributes of concern”
- Base Measures are mapped to processMax data entities
- Derived Measures are calculated from Base Measures
- Indicators are created from Base or Derived Measures to support Information Needs.

Key Relationships in MIM



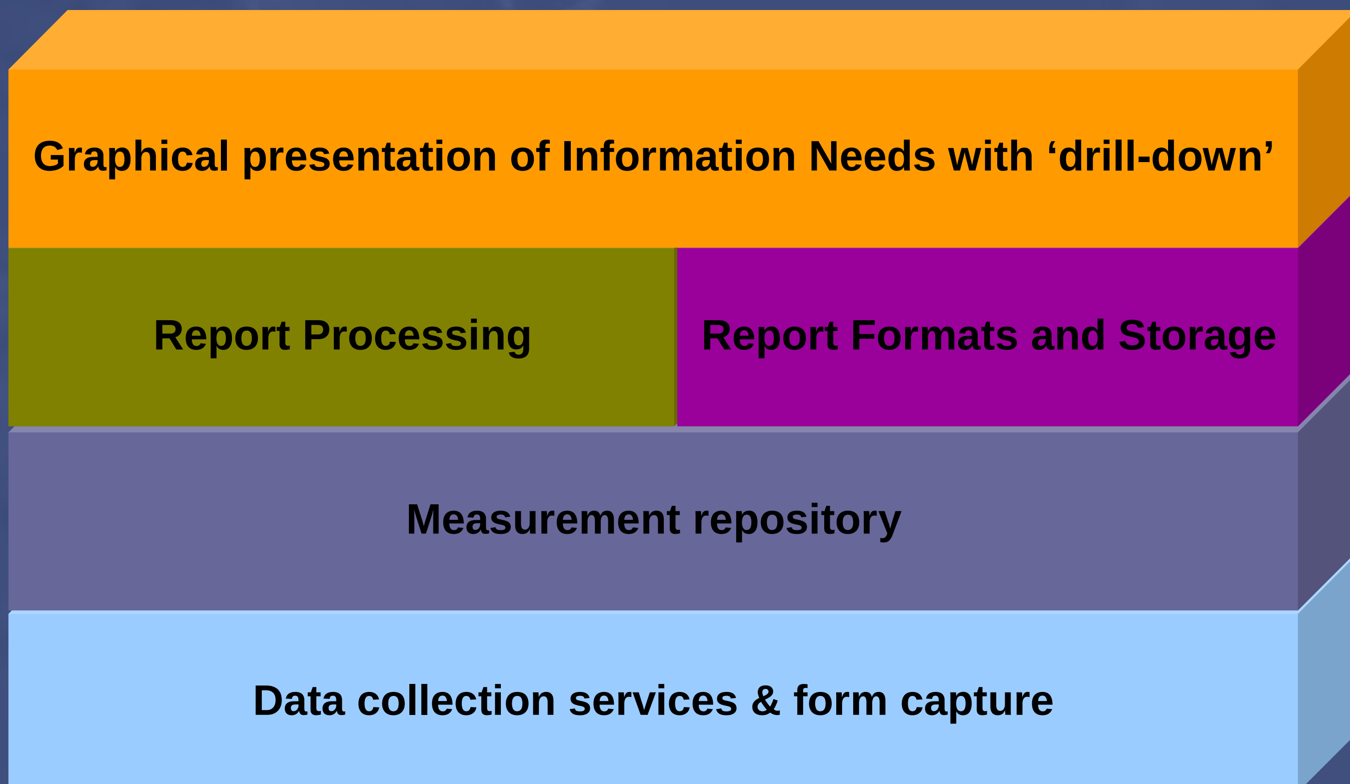
- Measurement Objectives – 18
  - Approximately equivalent to the Purpose section of each Process Area. They answer ‘Why are we measuring these particulars items?’ A Measurement Objective is associated with one or more Information Needs.
- Information Needs – 23
  - Correspond approximately to PMC SP 1.1 and GP 2.8 of each Process Area. An Information Need is associated with one or more Indicators, Derived Measures, and/or Base Measures.
- Indicators – 75
  - Trend or snapshots relying on Derived Measures and/or Base Measures
- Derived Measures – 35
  - Algorithms, programmed inside a report, relying on one or more Base Measures or other Derived Measures.
- Base Measures – 102
  - Defines what is to be measured, its source, when it is to be measured, how (i.e., count or record) it is to be measured, and data constraints, such as default values.

MIM Example

- **Information Need #4 Monitor project planning parameters**
  - Supported by ten indicators
  - Example Indicator: Trend of planned versus actual schedule for tracked tasks and milestones
    - Derived Measure 44 Total date variance to track slippage per Milestone
    - Derived Measure 97 Variance of original planned date versus actual date per Milestone
    - Base Measure 64 Planned milestone date and name per Milestone
    - Base Measure 65 Actual milestone completion date per Milestone
    - Base Measure 76 Planned Start Date, Task Name, Task Type, and Task Category per Tracked Task
    - Base Measure 77 Planned end date per Tracked Task
    - Base Measure 78 Actual end date per Tracked Task
    - Base Measure 79 Actual Start Date, Task Name, Task Type, and Task Category per Tracked Task

Elements of solution

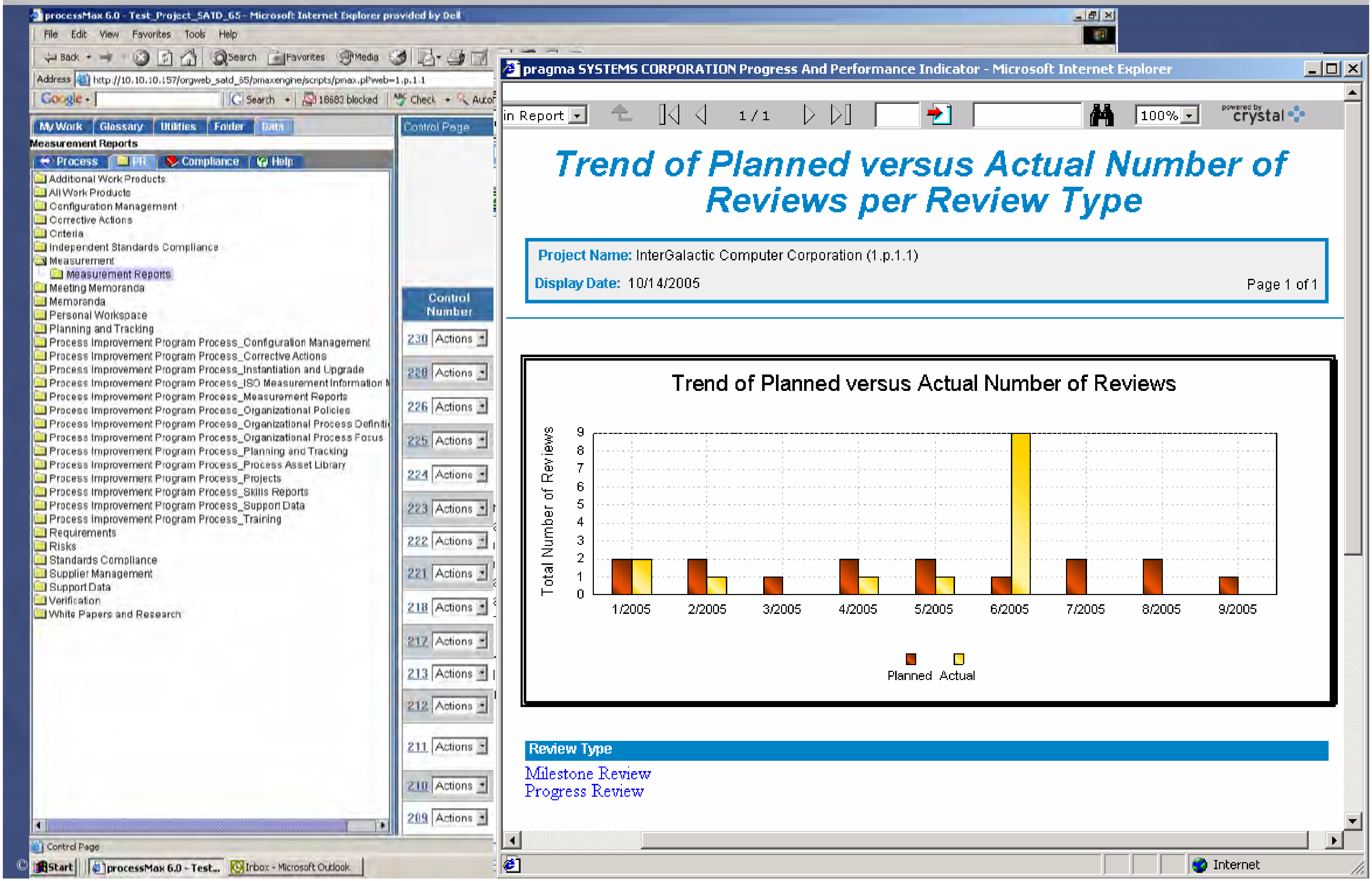
Senior Mgmt | SEPG Staff | Project Mgmt | SQA



Approach

- Data is captured close to source and in a timely way.
  - As user follows process steps, measurement data is automatically gathered by system
  - … or via meaningful query … Rather than ask “Is your risk exposure high?”, ask “What would be the cost if this risk were to occur?” and relate this to management reserve.
- As required or on a scheduled basis, a reporting user or the system selects from template reports and generates report(s) to support Information Need(s).
- Report template accesses Measurement Repository and retrieves relevant base measure data and stores output in repository.
- Any other user can browse stored report(s) and drill-down to satisfy Information Need(s)

Example


processMax 6.0 - Test_Project_SATD_65 - Microsoft Internet Explorer provided by Dell
My Work
Glossary
Utilities
Folder
Data
Measurement Reports
Process
PR
Compliance
Help
Additional Work Products
All Work Products
Configuration Management
Corrective Actions
Criteria
Independent Standards Compliance
Measurement
Measurement Reports
Meeting Memoranda
Memoranda
Personal Workspace
Planning and Tracking
Process Improvement Program Process_Configuration Management
Process Improvement Program Process_Corrective Actions
Process Improvement Program Process_Instantiation and Upgrade
Process Improvement Program Process_ISO Measurement Information
Process Improvement Program Process_Measurement Reports
Process Improvement Program Process_Organizational Policies
Process Improvement Program Process_Organizational Process Definiti
Process Improvement Program Process_Organizational Process Focus
Process Improvement Program Process_Planning and Tracking
Process Improvement Program Process_Process Asset Library
Process Improvement Program Process_Projects
Process Improvement Program Process_Skills Reports
Process Improvement Program Process_Support Data
Process Improvement Program Process_Training
Requirements
Risks
Standards Compliance
Supplier Management
Support Data
Verification
White Papers and Research
Control Page
Control Number
230 Actions
228 Actions
226 Actions
225 Actions
224 Actions
223 Actions
222 Actions
221 Actions
218 Actions
217 Actions
213 Actions
212 Actions
211 Actions
210 Actions
209 Actions
pragma SYSTEMS CORPORATION Progress And Performance Indicator - Microsoft Internet Explorer
Trend of Planned versus Actual Number of Reviews per Review Type
Project Name: InterGalactic Computer Corporation (1.p.1.1)
Display Date: 10/14/2005
Page 1 of 1
Trend of Planned versus Actual Number of Reviews
Total Number of Reviews
1/2005
2/2005
3/2005
4/2005
5/2005
6/2005
7/2005
8/2005
9/2005
Planned
Actual
Review Type
Milestone Review
Progress Review
Internet

Summary & Benefits

- CMMI measurement is organized and centralized.
- Standard set of measures instantiated for each project, with customization and tailoring
- Data gathering is automated and interactive reporting is provided
- Consistent set of measures is used across the organization – process integrated with tools
- Transformation of measurement process from an onerous task typically performed by a small specialist team to an integrated approach where data is captured at source and often without any user effort
- Management insight through ‘best of breed’ graphical reporting

Thank You

Thank you for your attention.

Questions?

SIEMENS

NORTHROP GRUMMAN

DEFINING THE FUTURE

Interpreting the CMMI: It Depends!

CMMI Technology Conference & User Group
14-17 November 2005

Rick Hefner, Ph.D.
Northrop Grumman Corporation

Sree Yellayi
Siemens Corporate Research

Background

- **Many organizations struggle with finding practical implementations of the CMMI model**
  - How does practice _____ apply to my time and materials contract?
  - How can a small project perform practice _____?
  - Is this evidence enough for practice _____?
- **The expert answer is frequently – it depends!**
- **This presentation will show how to interpret the model in a variety of contexts, including small projects, maintenance efforts, and time and materials contracts**

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Interpretation – The Dictionary Meaning

- **To explain or tell the meaning of**
- **To present in understandable terms**
- **To conceive in the light of**
  - individual belief
  - judgment
  - circumstance

SIEMENS

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Why Do Interpretation Issues Arise?

- **The CMMI model is a collection of industry best-practices**
- **These best-practices are based on an assumed project and organizational context**
  - These practices must be adapted for other situations

Small projects
Short projects
Maintenance projects
Research & development (internal) projects
Time and materials contracts

- **To better understand/interpret a practice:**
  - Review Process Area introductory material and Goals to understand the purpose of the process
  - Seek guidance from someone who has implemented that practice in your context
  - Understand the fundamental principles behind the practice

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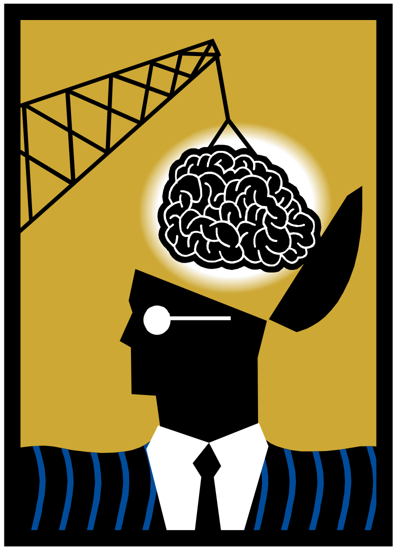
Do You Have an Open Mind?

- **Some practitioners want to believe the model does not apply to their situation**
  - If it doesn’t apply to me, I don’t have to do it!
- **Adopting the model means learning new ways of performing**
  - Must be willing to embrace new ideas, conceive that other’s approaches may be better than yours



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Underlying Principles of CMMI

1. **Process discipline leads to predictable project performance**
   - Say what you do; do what you say
   - Document the plans/processes
   - Communicate them to the performers and stakeholders
   - Audit to ensure we are following them
2. **Conscious choices lead to better processes**
   - E.g., identify relevant stakeholders and their involvement; identify work products to be controlled and the control method; define validation procedures and criteria, …
3. **Organizational learning improves project performance**
   - Capture what works, and what doesn't
   - Make rules (policies) to guide projects
   - Define expected processes, and let projects tailor them to fit
   - Capture work products and measures, and learn from them

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Small Projects

- **All the CMMI practices typically apply, but must be performed in a highly efficient manner**
  - Focus on discipline, not bureaucracy
- **With smaller projects**
  - Communication/coordination is simpler
  - It is more tempting (but more dangerous) to abandon discipline
  - The ability to divert staff to recover from mistakes is often less
- **Examples of interpretations**
  - Plans/processes may be less detailed, less formal
  - “Configuration Control Board” may simply be the project manager
  - Peer review may be a “buddy check” by a single individual

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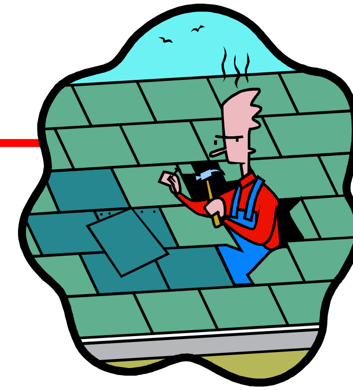
Short Projects

- ***"A 'project' is a managed set of interrelated resources that delivers one or more products to a customer or end user…. A project can be composed of projects."***
- **Proper application of CMMI involves proper definition of "project" to fit the work**
  - Modern contracts create tasks of various sizes and scopes
  - Some are too short/small to fit the CMMI definition of "project"
  - These tasks can be grouped together to better fit the CMMI context of "project"
- **Process discipline benefits longer projects by reducing the risk that something will go wrong over time**
  - Shorter projects have to focus on doing things right the first time, since little time is available for recovery

Maintenance Projects



- **The term "development" in CMMI does not exclude maintenance**
- **The Engineering process areas often need be interpreted in a smaller scope**
- **Example**
  - A problem in the field requires a "bug fix"
  - The engineer explores whether the product is broken or has unanticipated new requirements (Requirements Development, Requirements Management)
  - Potential changes to the design are considered (Technical Solution)
  - The fix is incorporated (Product Integration), regression tested (Verification) and deployed to the field

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Research and Development Projects

- Some organizations exclude R&D/internal projects from their CMMI initiative
- If you believe that CMMI is the fastest, cheapest way to develop a product, why wouldn't you use it everywhere?
- Guidance about small/short projects applies

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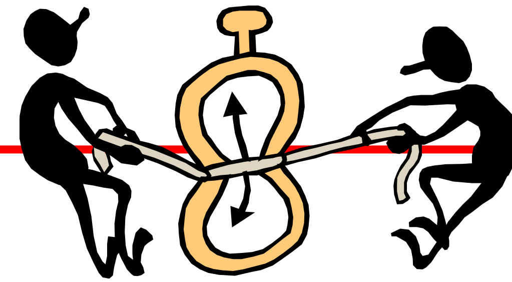
Time and Materials Contracts



- **CMMI applies to any kind of work, but….**
- **Adopting the CMMI assumes the project has the autonomy to perform the work in the best possible way**
  - I.e., can define their own process
- **Sometimes the customer sets limits on cost and schedule**
  - Projects can still meet the CMMI (e.g., Project Planning), but must adjust the work to fit the cost and schedule available
  - Process discipline means you do not agree to a scope of work you cannot hope to perform
- **Sometimes the customer defines the process to be used**
  - These processes may or may not comply with the CMMI (i.e., include the industry best practices required to perform efficiently and effectively)
  - Can advise the customer on the success of your proven processes and the value of CMMI practices

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Summary

- **Many organizations struggle with finding practical implementations of the CMMI model**
- **You can determine how to interpret the CMMI by:**
  - Keeping an open mind
  - Reviewing Process Area introductory material and Goals to understand the purpose of the process
  - Seeking guidance from someone who has implemented that practice in your context
  - Understanding the fundamental principles behind the practice

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DEFINING THE FUTURE

Achieving the Promised Benefits of CMMI

CMMI Technology Conference & User Group
14-17 November 2005

Rick Hefner, Ph.D.
Director, Process Initiatives
Northrop Grumman Corporation

Background

- **Many organizations have implemented the Capability Maturity Model Integrated (CMMI)**
- **Although they have achieved their desired maturity level and improvement goals, some organizations have seen little or no financial benefits**

What are the underlying principles of CMMI as they relate to productivity, predictability, and speed?

What is the return on investment?

What are the timelines for realizing these benefits?

CMMI® is a registered trademark of Carnegie Mellon University

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Agenda

- CMMI principles
- Industry data on return on investment
- A framework for measuring benefits
- Project performance benefits
- Organizational performance benefits
- Northrop Grumman experience
- Strategic actions needed to extract value from maturity

Projects Have Historically Suffered from Mistakes

People-Related Mistakes

1. Undermined motivation
2. Weak personnel
3. Uncontrolled problem employees
4. Heroics
5. Adding people to a late project
6. Noisy, crowded offices
7. Friction between developers and customers
8. Unrealistic expectations
9. Lack of effective project sponsorship
10. Lack of stakeholder buy-in
11. Lack of user input
12. Politics placed over substance
13. Wishful thinking

Process-Related Mistakes

14. Overly optimistic schedules
15. Insufficient Risk Management
16. Contractor failure Insufficient planning
17. Abandonment of planning under pressure
18. Wasted time during the fuzzy front end
19. Shortchanged upstream activities
20. Inadequate design
21. Shortchanged quality assurance
22. Insufficient management controls
23. Premature or too frequent convergence
25. Omitting necessary tasks from estimates
26. Planning to catch up later
27. Code-like-hell programming

Product-Related Mistakes

28. Requirements gold-plating
29. Feature creep
30. Developer gold-plating
31. Push me, pull me negotiation
32. Research-oriented development

Technology-Related Mistakes

33. Silver-bullet syndrome
34. Overestimated savings from new tools or methods
35. Switching tools in the middle of a project
36. Lack of automated source-code control

Standish Group, 2003 survey of 13,000 projects
- 34% successes
- 15% failures
- 51% overruns

Reference: Steve McConnell, Rapid Development

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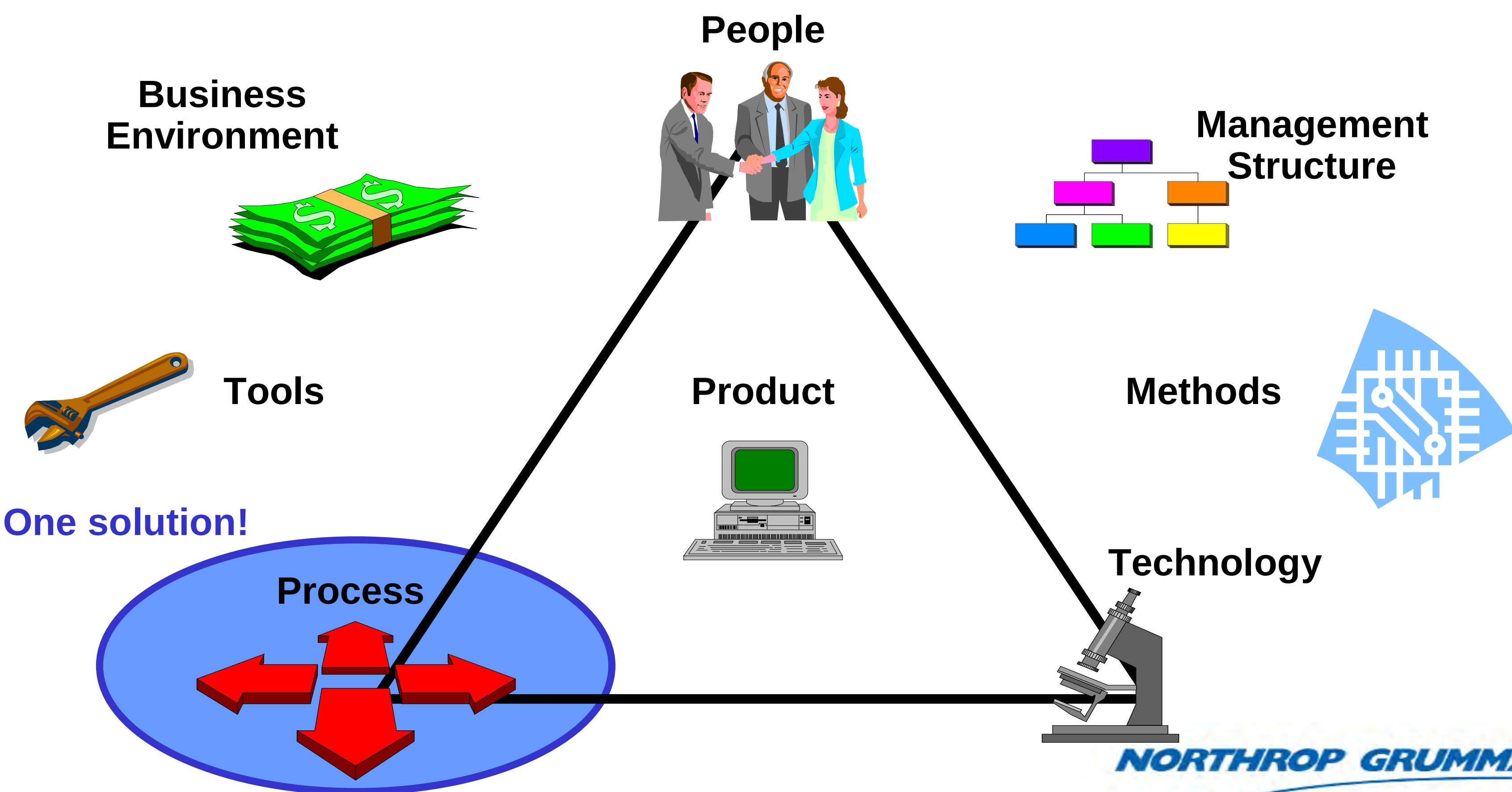
Many Approaches to Solving the Problem

- **Which weaknesses are causing my problems?**
- **Which strengths may mitigate my problems?**
- **Which improvement investments offer the best return?**



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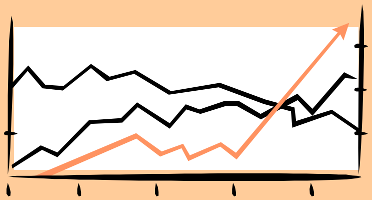
Approaches to Process Improvement

Data-Driven (e.g., Six Sigma, Lean)



- **Clarify what your customer wants (Voice of Customer)**
  - Critical to Quality (CTQs)
- **Determine what your processes can do (Voice of Process)**
  - Statistical Process Control
- **Identify and prioritize improvement opportunities**
  - Causal analysis of data
- **Determine where your customers/competitors are going (Voice of Business)**
  - Design for Six Sigma

Model-Driven (e.g., CMM, CMMI)

- **Determine the industry best practice**
  - Benchmarking, models
- **Compare your current practices to the model**
  - Appraisal, education
- **Identify and prioritize improvement opportunities**
  - Implementation
  - Institutionalization
- **Look for ways to optimize the processes**

What is the CMM?

- **Capability Maturity Models are a structured set of industry best practices**
  - Based on industry research and expert consensus
- **People adopt CMMs to emulate the behavior (and hopefully, performance) of successful organizations**
- **The value of a CMM is dependent upon**
  - Understanding the new practices you are adopting
  - Adapting them to your environment
  - Staying with them long enough to see the benefits

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How Do Mature Processes Help?

- **Process maturity gets at one source of the problem, e.g.,**
  - Are we using proven industry practices?
  - Does the staff have the resources needed to execute the process?
  - Is the organization providing effective project support?
- **The main benefits typically seen are:**
  - Improved predictability of project budgets and schedules
  - Improved management awareness of problems
  - Reduced re-work, <u>which improves predictability, cost, and schedule</u>

J. Herbsleb and D. Zubrow, "Software Process Improvement: An Analysis of Assessment Data and Outcomes"

- 13 organizations
- ROI of 4:1 to 9:1
- Improved quality, error rates, time to market, productivity

R. Dion, "Process Improvement and the Corporate Balance Sheet"

- ROI of 7.7:1: Reduced re-work, improved quality
- Two-fold increase in productivity

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The Knox Cost of Quality Model

- Extension of the Cost of Quality model used in manufacturing

Cost	Category	Definition	Typical Costs for Software
Conformance	Appraisal	Discovering the condition of the product	Testing and associated activities, product quality audits
	Prevention	Efforts to ensure product quality	SQA administration, inspections, process improvements, metrics collection and analysis
Non-conformance	Internal failures	Quality failures detected prior to product shipment	Defect management, rework, retesting
	External failures	Quality failures detected after product shipment	Technical support, complaint investigation, defect notification

Knox's Theoretical Model for Cost of Software Quality (Digital Technical Journal, vol.5, No. 4., Fall 1993, Stephen T. Knox.)

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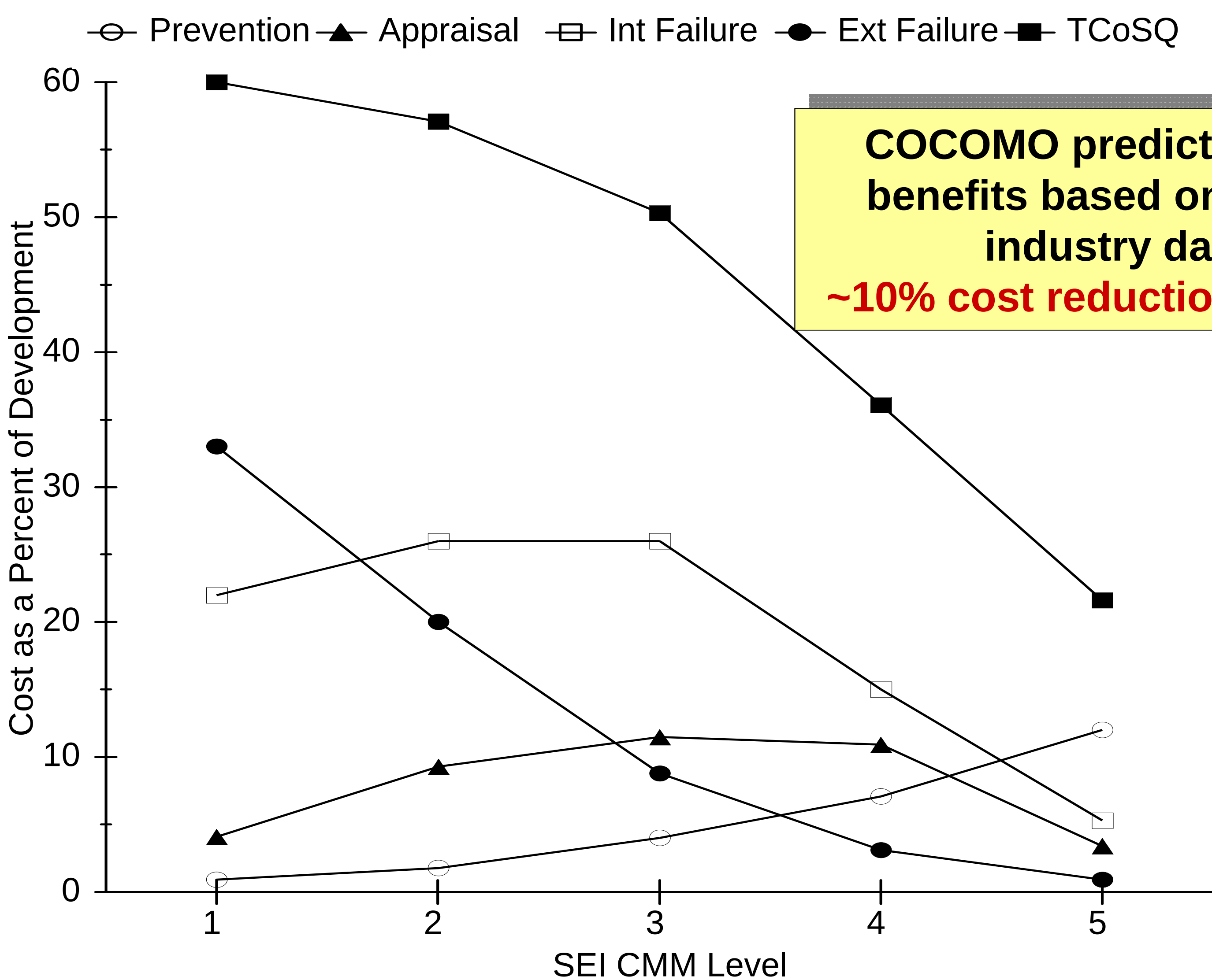
Knox Model – Theoretical Benefits



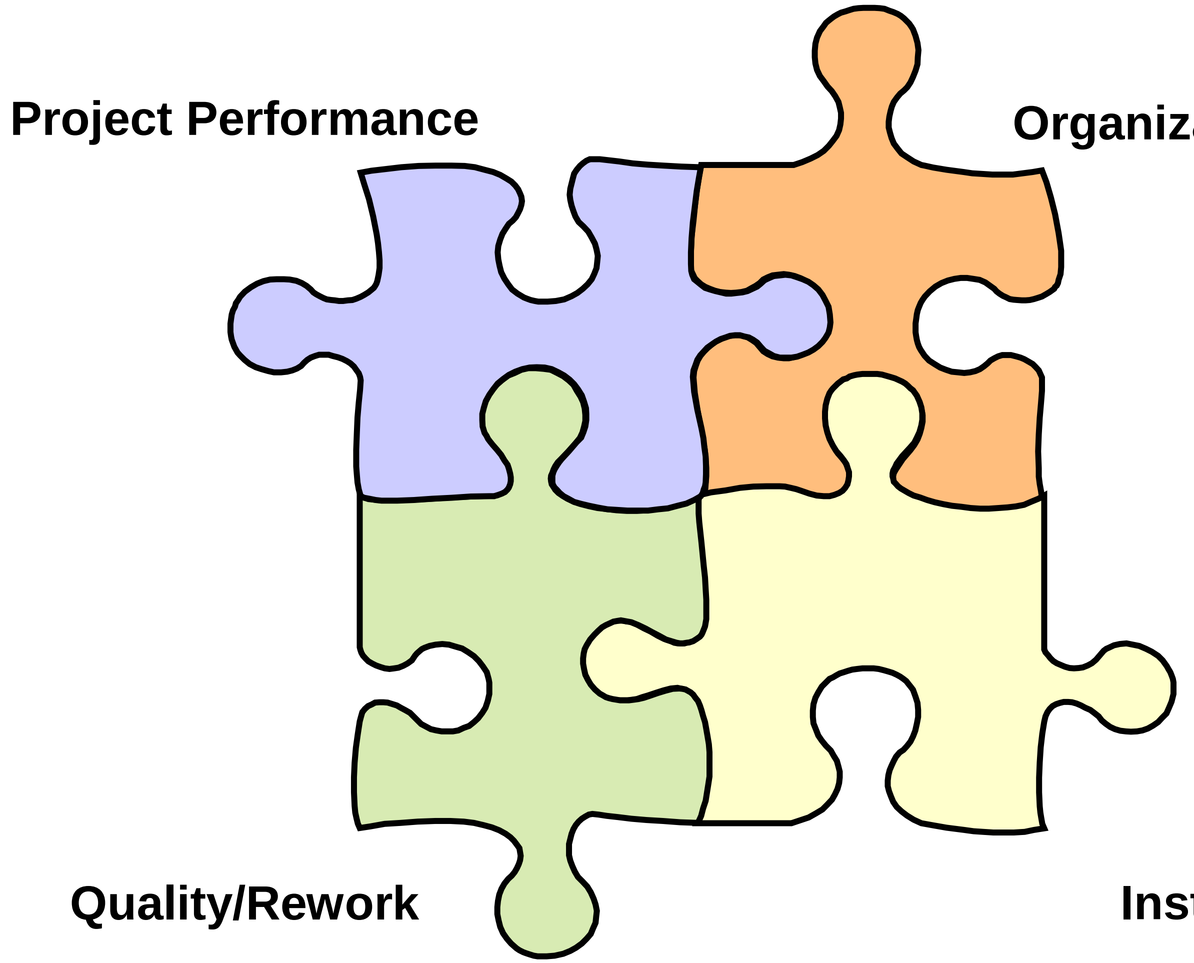
COCOMO predicts similar benefits based on current industry data:
~10% cost reduction per level

Where the Problem Sometimes Arises

- Some organizations are driven to achieve a maturity level only for it's marketing value

Improvement goals are not set realistically ("Level 5 in '05")	No one takes the improvement effort seriously
Only some of the projects participate in the improvement effort	Personnel perceive CMM/CMMI as more expensive
Only some of the projects get appraised	The other projects don't implement
Insufficient resources (e.g., training, QA, metrics, consultants)	People don't learn the new behaviors or become proficient
Management doesn't enforce the process	The benefits are not realized

CMMI Attacks Several Dimensions of the Problem



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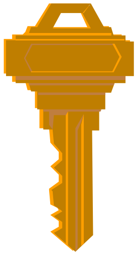
Project Performance

- **Project performance problems often arise because of incomplete or unrealistic planning**
  - Forgotten activities
  - Unconscious decisions
  - Overly-optimistic estimates
- **When cost/schedule pressure arises, people abandon the plans, leading to more problems**
  - Individual judgment versus best use of resources

CMMI

- **Identifies the elements of good planning**
  - Proven engineering processes
  - Estimates based on historical data, using these processes
- **When cost/schedule pressure arises, CMM/CMMI practices track and correct**
  - Reactive (L2)
  - Proactive, risk management (L3)
  - Quantitative management (L4)
- **QA, management ensures processes/plans are followed**



- ***Train project managers on how to use the tools (estimation, earned value, risk management)***
- ***Project managers (not organizational staff) must be responsible for implementing the improved processes***
- ***Demand realistic, data-driven estimates***

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Organizational Performance

- **Each project's processes are unique**
  - Personnel must re-learn with each project
  - Difficulty moving people from project to project
  - Historical data of little use in estimation
- **No way to compare project-to-project**
  - Which process was best?
  - What did we learn?

CMMI

- **Standard organizational process, tailored to fit each project**
  - Can be documented, trained, supported by templates
  - Over time, people learn the process
- **Common processes/measures allow better use of historical data**
  - Calibrate cost estimation models
  - Project to project comparisons
  - Over time, the organization can optimize the process

- ***Develop an organizational process(es) which fits the full range of your projects (small/large, all life cycles and project types)***
- ***Capture and use historical data (measurement repository)***
- ***Capture and share project documents (process asset library)***

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Rework/Quality

- **Focus on “faster and cheaper” leads to skipping of essential steps**
  - Key steps are not obvious, often counter intuitive
- **Fixing latent defects often accounts for 30-40% of project cost**
  - The cost of defects (rework) is seldom measured

CMMI

- **A disciplined engineering and management process**
  - Do it right the first time
  - CMM/CMMI identifies the essential steps
- **Peer reviews find defects early, where it is cost effective to fix them**
  - Requirements, designs, code, plans, etc.
  - Often more efficient and effective than testing
  - Many types (Fagan inspections, walkthroughs, desk checks, etc.)

- ***Focus on eliminating defects, not on faster and cheaper***
- ***Measure the cost of finding and fixing defects***
- ***Invest time in learning different methods of peer review and when each is effective***

Institutionalization

- **Some improvement efforts focus on quick fixes**
  - Driven by yearly budget cycles
  - Expectation that results will be immediate
- **It is tempting to reduce overhead to reduce cost**
  - Training
  - Staff support to projects
  - Use of outside process experts

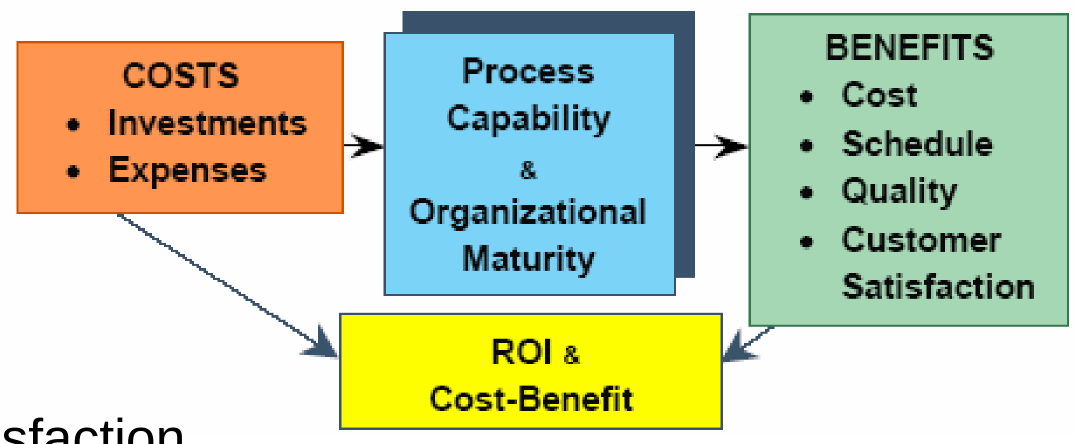
CMMI

- **Short-term investment for long-term gain**
  - Initial investment in the cost of change, learning curve, new overhead structures
  - Long-term benefits in increased productivity
- **Organizational infrastructure exists to support the policies and process**
  - Measurement repositories

- ***Expect 18-24 months before benefits begin to be realized***
- ***Senior management must demand that <u>everyone</u> follow the new processes***
- ***QA can be the organization's strongest tool – if they are focused!***

Benefits

- **The typical benefits are:**
  - Reduced cost
  - Faster schedules
  - Greater productivity
  - Higher quality
  - Increased customer satisfaction



- **Over 40 published studies on the benefits of CMM**
  - DoD DACS website: http://www.thedacs.com/databases/roi/
- **Similar results starting to be seen for CMMI**
  - "Demonstrating the Impact and Benefits of CMMI: An Update and Preliminary Results," Software Engineering Institute, CMU/SEI-2003-SR-009, Oct 2003
  - http://www.sei.cmu.edu/cmmi/results/results-by-category.html

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Typical CMMI Benefits Cited in Literature

- **Reduced Costs**
  - 33% decrease in the average cost to fix a defect (Boeing)
  - 20% reduction in unit software costs (Lockheed Martin)
  - Reduced cost of poor quality from over 45 percent to under 30 percent over a three year period (Siemens)
  - 10% decrease in overall cost per maturity level (Northrop Grumman)
- **Faster Schedules**
  - 50% reduction in release turnaround time (Boeing)
  - 60% reduction in re-work following test (Boeing)
  - Increase from 50% to 95% the number of milestones met (General Motors)
- **Greater Productivity**
  - 25-30% increase in productivity within 3 years (Lockheed Martin, Harris, Siemens)
- **Higher Quality**
  - 50% reduction of software defects (Lockheed Martin)
- **Customer Satisfaction**
  - 55% increase in award fees (Lockheed Martin)

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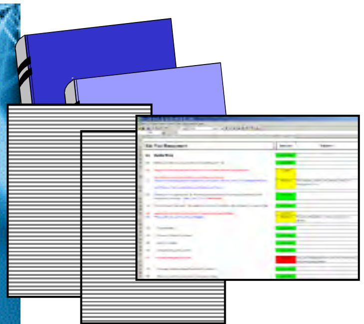
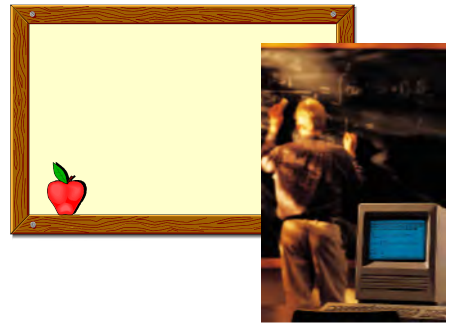
Organizational Infrastructure Required for CMMI Level 3

Policies, Processes, Templates & Tools

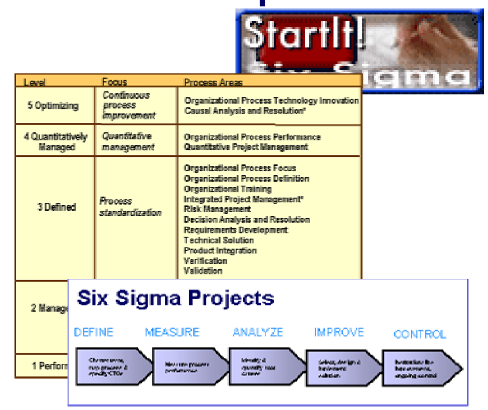


Process Group

Training Program

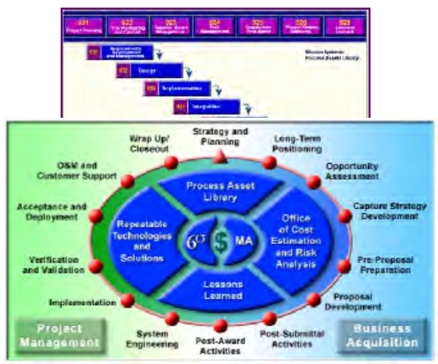


Process Improvement



Measurement Repositories Predictive Modeling

Best-Practice Libraries



Audits & Appraisals

Communications

Developing and maintaining mature processes requires significant time and investment in infrastructure

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Northrop Grumman Mission Systems Approach

Mission Success Requires Multiple Approaches

Risk Management

Systems Engineering

Independent Reviews

Training, Tools, & Templates

Dashboards for Enterprise-Wide Measurement

Communications & Best-Practice Sharing

Robust Governance Model (Policies, Processes, Procedures)

CMMI Level 5 for Software, Systems, and Services

ISO 9001 and AS-9100 Certification

Six Sigma

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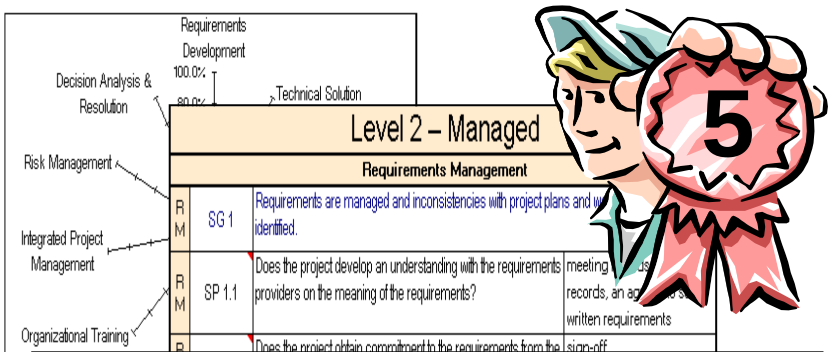
Process Effectiveness

Audits & Appraisals

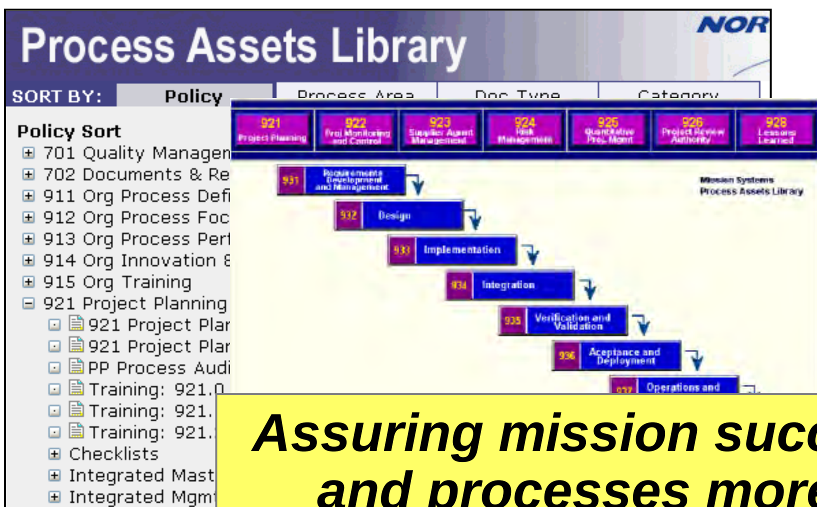


20 Northrop Grumman sites externally appraised at CMMI Level 5

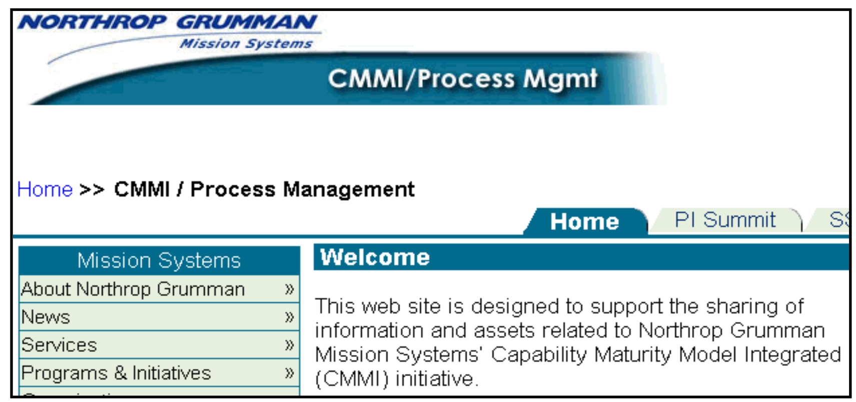
Staff Competence & Training

- **CMMI & Six Sigma courses**
- **Policies & processes course**
- **Standard Training Modules for each job function: engineering, project management, QA, CM, etc.**

Process Asset Library



Communications & Collaboration



Assuring mission success by making the people and processes more informed and effective

Program Effectiveness

- **Six Sigma connects process improvement and business value**

DEFINE	MEASURE	ANALYZE	IMPROVE	CONTROL
Charter team, map process & specify CTQs	Measure process performance	Identify & quantify root causes	Select, design & implement solution	Institutionalize improvement, ongoing control

- **Six Sigma projects can help focus and measure CMMI-driven process improvements**
  - Identify the customer's needs, maximize the value/cost
  - Tools for management by variation (CMMI Levels 4 and 5)
- **Results to date**
  - 4000 Green Belts, 200 Black Belts, 12 Master Black Belts
  - 500 completed Six Sigma projects, 250 in progress
  - Significant benefit to our customer – lower costs, better performance

Assuring mission success by identifying the customer's needs and reducing defects

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Operational Effectiveness

People

Parametric Modeling Experts
Risk and Predictive Modeling Analysis
Certified Function Point Specialists
Six Sigma Black Belts

Presence

Professional Society Board Members
Active on Government Working groups
Key participants on Milestone reviews)

Tools

Commercial Modeling Tools
Northrop Grumman Developed Tools

Process

Structured Project Reporting, Training
Standardization of Data, Metrics Manual, Approval
CMMI Measurement,

Process Capability Data Repository

Software, Hardware,
Accounting
Productivity, Defects,
Maintenance
Phase Relationships,
Systems Engineering
Functions,
Lessons Learned

Product

Risk Analysis
Cost Estimates
Cost Estimation Relationships
Program Benchmarking
Life Cycle Productivity Analysis
Software Sizing and Modeling
Predictive Modeling
Quantitative Management

Programs

Monitor, Manage, Report, Update and Calibrate

Assuring mission success by providing independent cost, schedule and risk realism

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Lessons Learned

- **Process improvement means changing the process**
  - More important to learn the new behaviors than to “go through the motions”
- **Resistance often comes from fear of failure**
  - Walk the talk -- management at all levels must communicate the need for continuous improvement
  - Focus on learning from your mistakes and getting better
  - Training and assistance helps people in trying new processes
- **Six Sigma is a strong enabler for process improvement**
  - Focus on data, measurement systems, process improvement
  - Tying improvements to business goals
  - Allows the projects and organization to optimize the CMMI practices for maximum customer benefit

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DEFINING THE FUTURE

Service Extensions to the CMMI

5th Annual CMMI Technology Conference
Denver, CO

November 14-17, 2005

Craig R. Hollenbach
Technical Fellow
Northrop Grumman Corporation

Agenda

- **Purpose**
- **Sponsors & Membership**
- **Service Coverage in Existing CMMI-SE/SW, v1.1**
- **Industry Service Models or Standards**
  - Rationale for a Services CMMI
- **Schedule**
- **Industry Participation**
- **Issues References**

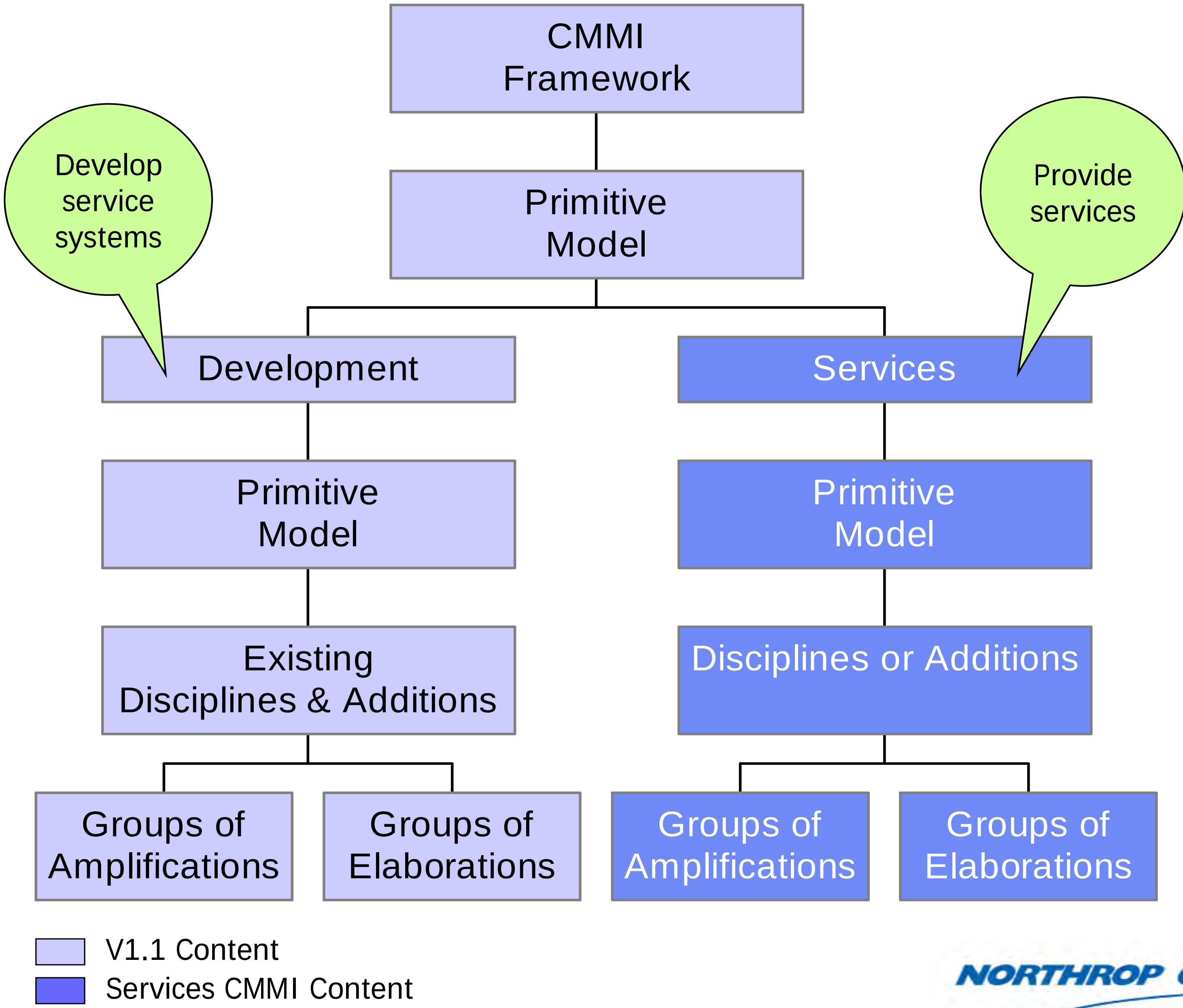
Purpose & Sponsors

- **Purpose:**
  - to extend the CMMI framework to cover the provision of services
- **Sponsors:**
  - CMMI Steering Group
  - DoD OSD
  - NDIA, Systems Engineering Division
  - SEI
  - Northrop Grumman – proposed to sponsor a Services CMMI to the CMMI Steering Group in Nov 2004

Services Team Membership

- **Membership:**
  - Jeff Zeidler (Boeing)
  - Steve Stern (Lockheed Martin)
  - Brandon Buteau (Northrop Grumman)
  - Craig Hollenbach (Northrop Grumman) - Lead
  - Roy Porter (Northrop Grumman)
  - Hal Wilson (Northrop Grumman)
  - Gordon Ward (Raytheon)
  - Jerry Simpson (SAIC)
  - Drew Allison (SSCI)
  - Eileen Forrester (SEI)
  - Barbara Tyson (SEI)
  - Eileen Clark (SRA)

Service Coverage in CMMI-SE/SW, v1.1



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What is Not Covered in CMMI-SE/SW, v1.1

Candidate model content could cover:

- **Service Request and Incident Management**
  - Service requests and incidents regarding the service are identified, registered, tracked, analyzed, and resolved.
- **Capacity Management**
  - Responsible for ensuring adequate capacity is available at all times to meet the requirements of the business.
- **Availability Management**
  - Process of managing the ability of a component or service to perform its required function at a stated instant or over a stated period of time
- **Service Continuity Management**
  - Concerned with managing an organization's ability to continue to provide a pre-determined and agreed level of IT services to support the minimum business requirements following an interruption to the business.

What is Not Covered in CMMI-SE/SW, v1.1 (cont.)

- **Release Management**
  - Process of testing and introducing together a collection of new and/or changed configuration items into the live environment
- **Service Delivery**
  - Consistently perform a well-defined service delivery process that integrates all service delivery activities to deliver correct, consistent IT services effectively and efficiently.
- **Resource Management**
  - Control of the resources (hardware and software) needed to deliver the services is maintained.

Industry Service Models or Standards

Candidate IT service models and standards include:

- Information Technology Infrastructure Library (ITIL)
- Control Objects for Information and related Technology (COBIT)
- Information Technology Services CMM (ITSCMM)
- British Standard 15000: IT Service Management (BS 15000)

The Services CMMI team is investigating non-IT service models and standards.

Rationale - If IT service models exist, why do we need a CMMI for Services?

- **The CMMI emphasizes institutionalization of process maturity.**
  - The CMMI divides improvements into incremental efforts.
- **A CMMI for Services would rapidly leverage investments by the current CMMI user base to bring process maturity to their services efforts.**
  - CMMI-based improvements have a demonstrated ROI.
  - The CMMI provides a familiar vocabulary.
- **There is little guidance for appraisers and organizations on applying the CMMI to services efforts.**
  - "Implementation models" within companies differ between SE/SW and services.
  - The CMMI is supported by standard appraisal methods.

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Rationale - If IT service models exist, why do we need a CMMI for Services?

- **Current IT models do not address the development of service systems as thoroughly as the CMMI.**
- **A CMMI for Services would summarize essential elements from current IT service models.**
  - Maps from IT service models to a Services CMMI would enable organizations to refer to existing models for extensive best practices for services
  - Reduces preparation costs for appraisals against multiple models

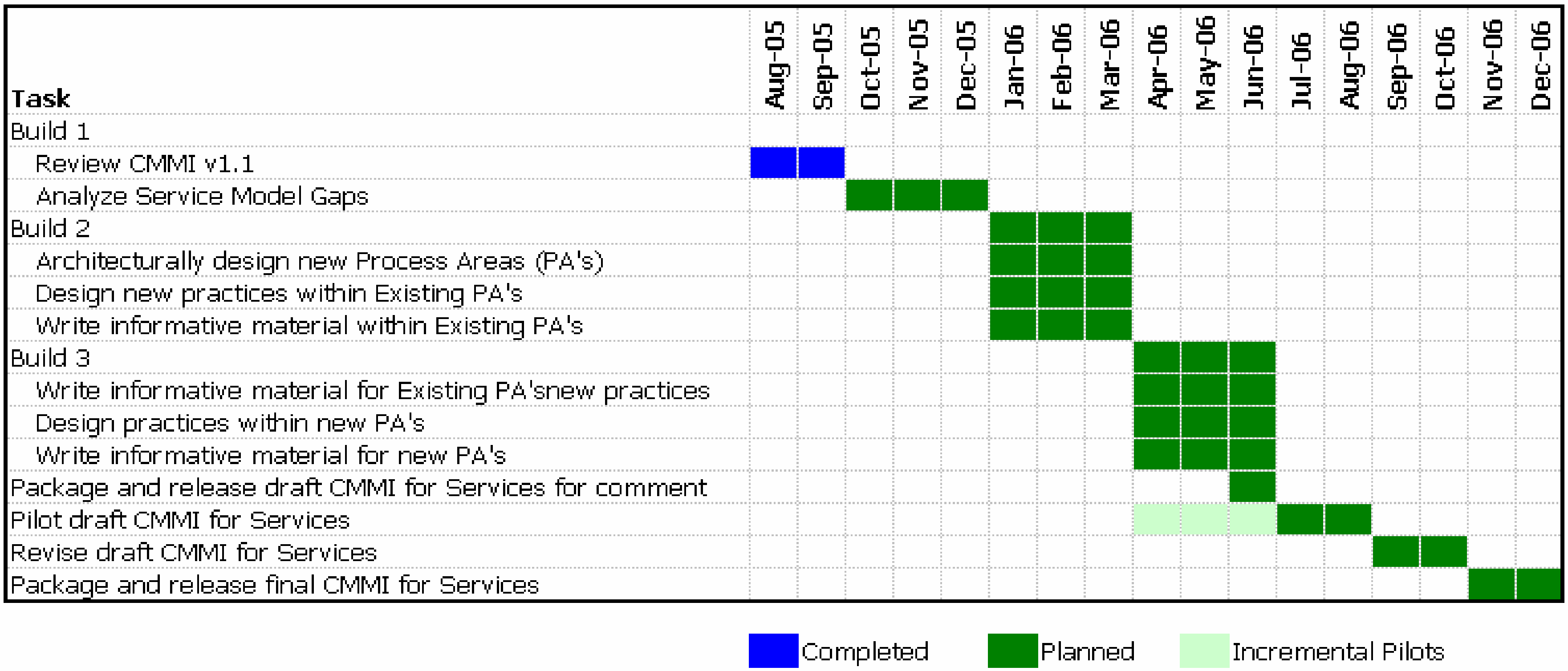
Why do we need a CMMI for Services?

- Applying the CMMI to services requires significant interpretation of appraisers and organizations, but there is no guidance.
- Current IT services models do not completely address service development and initiation.
- A CMMI for Services would re-use a familiar vocabulary and common model components.
- A CMMI for Services would summarize essential elements from current IT service models.
- “Implementation models” for development differ from those for services.

Why do we need a CMMI for Services?

- A CMMI for Services includes additional process areas necessary for full process institutionalization and innovation.
- CMMI for Services maturity levels divide improvements into incremental efforts.
- An extensive CMMI user community can leverage the CMMI framework to extend current maturity into service domains.
- A CMMI for Services would summarize essential principles from and provide maps to current IT service models, allowing for integrated improvement efforts and coordinated best practices.

Schedule



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Industry Participation

- Participate in piloting of Services CMMI
- Provide model feedback
- Visit the public Services CMMI (BSCW site)

Accomplishments To Date

- The Services CMMI Team has coordinated well with the version 1.2 team on saving the CMMI framework's common content.
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  - Project (definite beginning and end)
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References

- CMMI - http://www.sei.cmu.edu/cmmi/cmmi.html
- ITIL - http://www.ogc.gov.uk/index.asp?id=2261
- itSMF - http://www.itsmf.com/
- BS 15000 - http://www.bs15000.org.uk/
- COBIT - http://www.isaca.org/
- ITSCMM - http://www.itservicecmm.org/
- Interpreting Capability Maturity Model Integration (CMMI) for Operational Organizations, Brian P. Gallagher, Technical Note, CMU/SEI-2002-TN-006, April 2002
- Interpreting Capability Maturity Model Integration (CMMI) for Service Organizations – a Systems Engineering and Integration Services Example, Mary Anne Herndon, SAIC, et al, Technical Note, CMU/SEI-2003-TN-005, November 2003
- Services CMMI Public Website - https://bscw.sei.cmu.edu/bscw/bscw.cgi/0/424939

NORTHROP GRUMMAN

DEFINING THE FUTURE

Service Extensions to the CMMI

5th Annual CMMI Technology Conference
Denver, CO

November 14-17, 2005

Craig R. Hollenbach
Technical Fellow
Northrop Grumman Corporation

Agenda

- **Purpose**
- **Sponsors & Membership**
- **Service Coverage in Existing CMMI-SE/SW, v1.1**
- **Industry Service Models or Standards**
    - Rationale for a Services CMMI
- **Schedule**
- **Industry Participation**
- **Issues References**

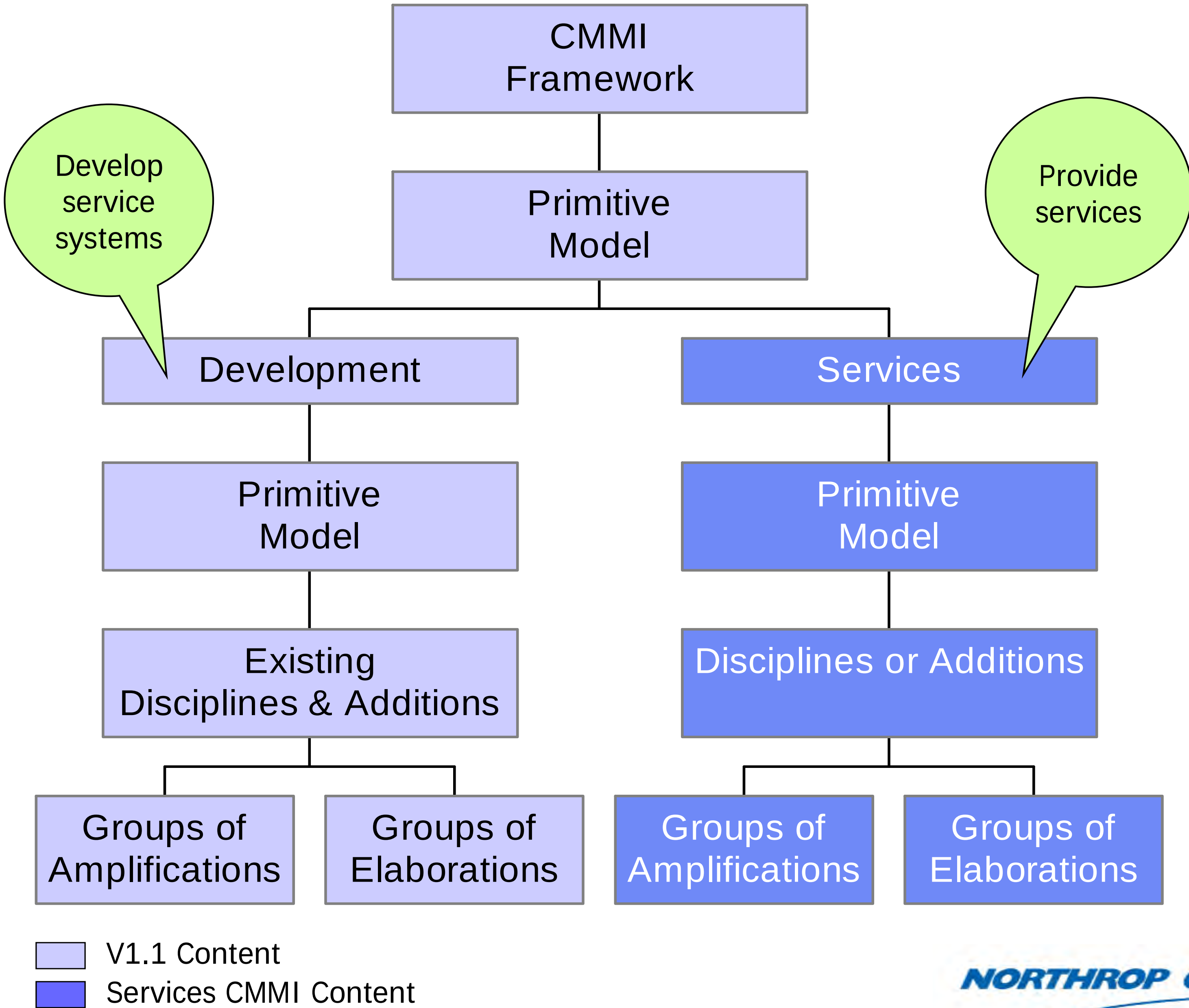
Purpose & Sponsors

- **Purpose:**
  - to extend the CMMI framework to cover the provision of services
- **Sponsors:**
  - CMMI Steering Group
  - DoD OSD
  - NDIA, Systems Engineering Division
  - SEI
  - Northrop Grumman – proposed to sponsor a Services CMMI to the CMMI Steering Group in Nov 2004

Services Team Membership

- **Membership:**
  - Jeff Zeidler (Boeing)
  - Steve Stern (Lockheed Martin)
  - Brandon Buteau (Northrop Grumman)
  - Craig Hollenbach (Northrop Grumman) - Lead
  - Roy Porter (Northrop Grumman)
  - Hal Wilson (Northrop Grumman)
  - Gordon Ward (Raytheon)
  - Jerry Simpson (SAIC)
  - Drew Allison (SSCI)
  - Eileen Forrester (SEI)
  - Barbara Tyson (SEI)
  - Eileen Clark (SRA)

Service Coverage in CMMI-SE/SW, v1.1



NORTHROP GRUMMAN

What is Not Covered in CMMI-SE/SW, v1.1

Candidate model content could cover:

- **Service Request and Incident Management**
  - Service requests and incidents regarding the service are identified, registered, tracked, analyzed, and resolved.
- **Capacity Management**
  - Responsible for ensuring adequate capacity is available at all times to meet the requirements of the business.
- **Availability Management**
  - Process of managing the ability of a component or service to perform its required function at a stated instant or over a stated period of time
- **Service Continuity Management**
  - Concerned with managing an organization's ability to continue to provide a pre-determined and agreed level of IT services to support the minimum business requirements following an interruption to the business.

What is Not Covered in CMMI-SE/SW, v1.1 (cont.)

- **Release Management**
  - Process of testing and introducing together a collection of new and/or changed configuration items into the live environment
- **Service Delivery**
  - Consistently perform a well-defined service delivery process that integrates all service delivery activities to deliver correct, consistent IT services effectively and efficiently.
- **Resource Management**
  - Control of the resources (hardware and software) needed to deliver the services is maintained.

Industry Service Models or Standards

Candidate IT service models and standards include:

- Information Technology Infrastructure Library (ITIL)
- Control Objects for Information and related Technology (COBIT)
- Information Technology Services CMM (ITSCMM)
- British Standard 15000: IT Service Management (BS 15000)

The Services CMMI team is investigating non-IT service models and standards.

Rationale - If IT service models exist, why do we need a CMMI for Services?

- **The CMMI emphasizes institutionalization of process maturity.**
  - The CMMI divides improvements into incremental efforts.
- **A CMMI for Services would rapidly leverage investments by the current CMMI user base to bring process maturity to their services efforts.**
  - CMMI-based improvements have a demonstrated ROI.
  - The CMMI provides a familiar vocabulary.
- **There is little guidance for appraisers and organizations on applying the CMMI to services efforts.**
  - “Implementation models” within companies differ between SE/SW and services.
  - The CMMI is supported by standard appraisal methods.

Rationale - If IT service models exist, why do we need a CMMI for Services?

- **Current IT models do not address the development of service systems as thoroughly as the CMMI.**
- **A CMMI for Services would summarize essential elements from current IT service models.**
  - Maps from IT service models to a Services CMMI would enable organizations to refer to existing models for extensive best practices for services
  - Reduces preparation costs for appraisals against multiple models

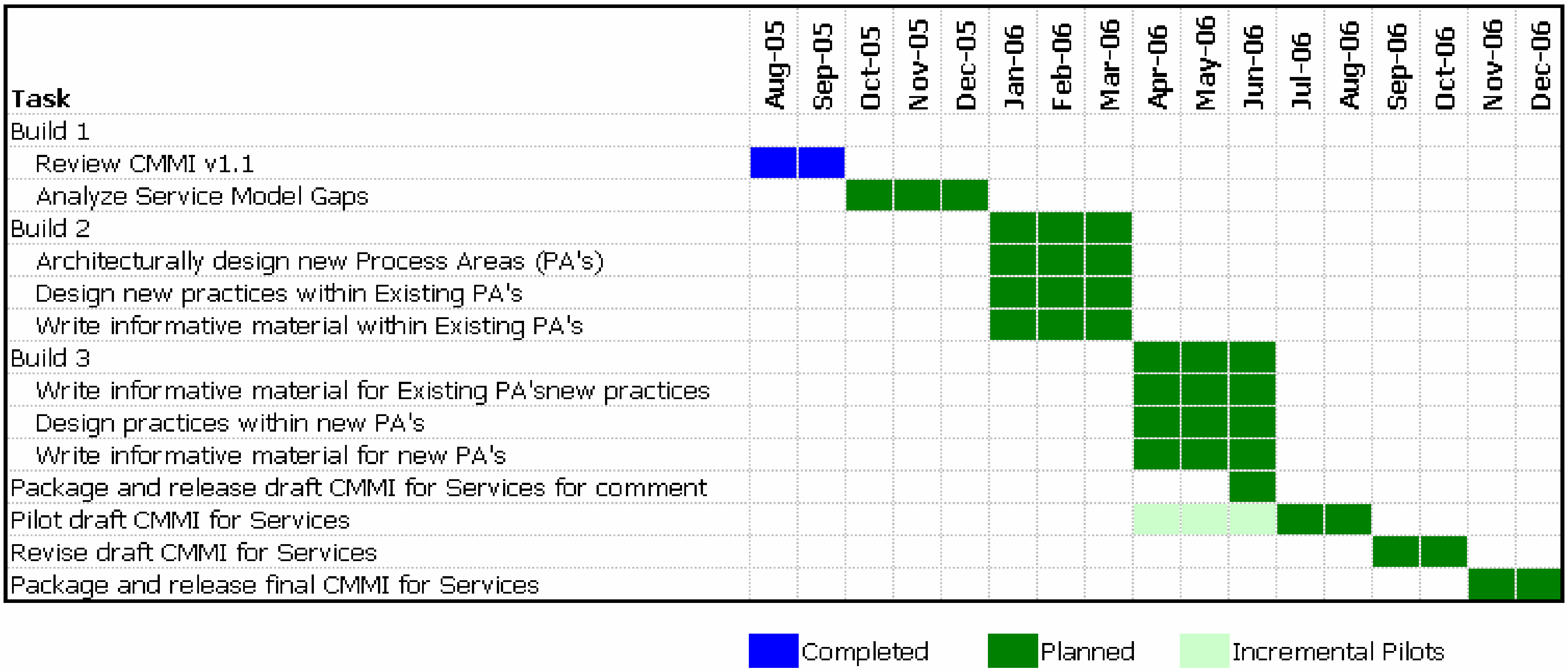
Why do we need a CMMI for Services?

- Applying the CMMI to services requires significant interpretation of appraisers and organizations, but there is no guidance.
- Current IT services models do not completely address service development and initiation.
- A CMMI for Services would re-use a familiar vocabulary and common model components.
- A CMMI for Services would summarize essential elements from current IT service models.
- "Implementation models" for development differ from those for services.

Why do we need a CMMI for Services?

- A CMMI for Services includes additional process areas necessary for full process institutionalization and innovation.
- CMMI for Services maturity levels divide improvements into incremental efforts.
- An extensive CMMI user community can leverage the CMMI framework to extend current maturity into service domains.
- A CMMI for Services would summarize essential principles from and provide maps to current IT service models, allowing for integrated improvement efforts and coordinated best practices.

Schedule



Task
Aug-05
Sep-05
Oct-05
Nov-05
Dec-05
Jan-06
Feb-06
Mar-06
Apr-06
May-06
Jun-06
Jul-06
Aug-06
Sep-06
Oct-06
Nov-06
Dec-06
Build 1
Review CMMI v1.1
Analyze Service Model Gaps
Build 2
Architecturally design new Process Areas (PA's)
Design new practices within Existing PA's
Write informative material within Existing PA's
Build 3
Write informative material for Existing PA'snew practices
Design practices within new PA's
Write informative material for new PA's
Package and release draft CMMI for Services for comment
Pilot draft CMMI for Services
Revise draft CMMI for Services
Package and release final CMMI for Services
Completed
Planned
Incremental Pilots

Industry Participation

- Participate in piloting of Services CMMI
- Provide model feedback
- Visit the public Services CMMI (BSCW site)

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Reducing Variation at Each CMMI Maturity Level

Tim Kasse

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Welcome

WelKom

Huan Yín

Bienvenido

Bienvenue

Wilkommen

ΚΆΛΟΣ ΟΡΙΣΑΤΕ

Bienvenuto

Välkommen

Tervetuloa

Witamy

ברוכים הבאים

Continuous Variation of Reducing Variation

- The ideas of variation found in this presentation
  - Provide the backdrop for using the CMMI model as the basis for an organization’s process improvement initiative
  - Show that this journey is synonymous with a journey of reducing variation

Understanding Variation

Understanding Variation
The Key to Managing Chaos
Donald J. Wheeler, SPC Press, 2000

Process Change and Variation

- Dr. Wheeler shared his interpretation of Dr. Walter Shewhart's approach to interpreting data.
  - "We analyze numbers in order to know when a change has occurred in our process of system…." "…
  - Some variation is routine, run-of-the-mill, and is to be expected even when the process has not changed.
  - Other variation is exceptional, outside the bounds of routine, and therefore to be interpreted as a signal of process change…." "…

Understanding Variation

- Understanding variation is achieved by collecting and analyzing process and product measures so that special causes of variation can be identified and addressed to achieve predictable performance
- All characteristics of processes and products display variation when measured over time
- Variation may be due to
  - Natural or common causes
  - Special or “assignable” causes of variation
- Understanding and controlling variation is the essence of CMMI Maturity L4 & L5

Common Causes of Variation

- Common causes of variation
  - Variation in process performance due to normal interaction among the process components (people, machines, material, environment, and methods)
  - Characterized by a stable and consistent pattern of measured values over time
  - Variation due to common cause is random but will vary within predictable bounds
  - Unexpected results are extremely rare
  - Predictable is synonymous with in control

Special Causes of Variation

- Special or Assignable causes of variation
  - Arise from events that are not part of the normal process
  - Represent sudden or persistent abnormal changes due to one or more of the process components
    - inputs to the process
    - environment
    - process steps themselves
    - the way the process steps are executed
  - **Examples** of assignable causes of variation include inadequately trained people, tool failures, failures to follow the process

Process Variation

- Reducing process variation is an important aspect to quantitative management:
  - It is important to focus on ***subprocesses that can be controlled to achieve a predictable performance***
- Statistical process control is often better focused on organizational areas such as Product Lines where there is high similarity of processes, than on the organization's entire set of products

CMMI Overview

Level	Process Characteristics	Process Areas
5 Optimizing	Focus is on quantitative continuous process improvement	Causal Analysis and Resolution Organizational Innovation and Deployment
4 Quantitatively Managed	Process is measured and controlled	Quantitative Project Management Organizational Process Performance
3 Defined	Process is characterized for the organization and is proactive	Requirements Development Technical Solution Product Integration Verification Validation Organizational Process Focus Organization Process Definition Organizational Training Integrated Project Management Integrated Teaming Organizational Environment For Integration Integrated Supplier Management Risk Management Decision Analysis & Resolution
2 Managed	Process is characterized for projects and is often reactive	Requirements Management Project Planning Project Monitoring and Control Supplier Agreement Management Product and Process Quality Assurance Configuration Management Measurement and Analysis
1 Initial	Process is unpredictable, poorly controlled, and reactive	

Maturity Level 1: Initial

- Processes are usually ad hoc and chaotic
- The organization usually does not provide a stable environment
- Success depends on the competence and heroics of the people in the organization and not on the use of proven processes
- Maturity level 1 organizations are characterized by a tendency to over commit, abandon processes in the time of crisis, and not be able to repeat their past successes

Variation Among Individuals

- One of the traits of CMMI Maturity Level 1 is that the process "belongs" to the people."
  - If others follow a process, it is normally due to the strong personality of someone on the project who has experienced using processes in another environment
- From a variation point of view, a level one organization has great variation based on its individual employees following their own process paths. This is why maturity level one companies depend so heavily on the heroics of its people

Maturity Level 2: Managed

- **Projects** ensure that requirements are managed and that processes are planned, performed, measured, and controlled
- The process discipline reflected by maturity level 2 helps to ensure that existing practices are retained during times of stress
- At maturity level 2, requirements, processes, work products, and services are managed
  - The status of the work products and the delivery of services are visible to management at defined points
  - The work products and services satisfy their specified requirements, standards, and objectives

Managing the Project Involves

- Estimating the scope and work that needs to be performed
- Developing mechanisms to acquire identified products
- Developing a project plan
- Getting commitments to the plan
- Working with suppliers to acquire identified products
- Monitoring progress against the plan
- Identifying and analyzing risks
- Taking action to address significant deviations from the plan
- Taking action to appropriately mitigate risks

Measurement and Analysis to Support Projects

- Support projects includes specifying the objectives of measurement and analysis such that they are aligned with established information needs and business objectives
  - Defining the measures to be used, the data collection process, the storage mechanisms, the analysis processes, the reporting processes, and **the feedback processes**
  - Providing objective results that can be used in making business judgments and taking appropriate corrective actions

Basic Measures

- Project Management Measures
  - Size and complexity
  - Effort and Cost
  - Schedule
  - Computer Resources
  - Data Management
  - Knowledge and Skills
  - Stakeholder Involvement
  - Technical Performance
  - Commitments
  - Critical Dependencies
  - Quality

More Advanced Measures

- Earned value
- Defect density
- Peer Review Effectiveness
- Testing Effectiveness
- Test Coverage
- Reliability
- Maintainability
- Interoperability

Project's Processes to Reduce Variation

- At CMMI Maturity Level 2, processes normally belong to the project and are enforced by the Project Manager
- The processes, standards, guidelines, checklists, and templates are enforced for all of the project members to achieve more uniformity in development and product quality
- Assuming that all projects follow some form of process, the amount of variation that was seen in organizations of maturity level 1 is reduced even if all of the projects followed a different process

Maturity Level 3: Defined

- Processes are well characterized and understood, and are described in standards, procedures, tools, and methods
- The organization's set of standard processes, which is the basis for maturity level 3, is established and improved over time.
  - These standard processes are used to establish consistency across the organization
  - Projects establish their defined processes by tailoring the organization's set of standard processes according to tailoring guidelines

Maturity Level 3: Defined - 2

- The organization's management establishes process objectives based on the organization's set of standard processes
- **Processes are typically described in more detail and more rigorously than at maturity level 2**

Organizational Processes to Reduce Variation

- At The Organizational Level, an organization that wishes to achieve CMMI Maturity Level 3 needs to have its processes owned by the organization for economy of scale to be realized and process measurement to make practical sense
- These process definitions are tailored and incorporated into the project's defined processes throughout the organization and thus variation in project development and product and service quality is again reduced

Organizational Processes to Reduce Variation - 2

- An organizational measurement repository is established and maintained which contains both product and process measures based on the organization’s set of standard processes along with the information needed to understand and interpret the measures
  - Trends can be seen and predictability can be start to be achieved
  - Process performance baselines can now be developed to support quantitative management later

Organization's Process Assets

Measurement Repository

Process Asset Library

Life-cycle Models

Tailoring Guidelines

Support Environment

Organization's Standard Processes

Process Architecture

Process Elements

Maturity Level 4: Quantitatively Managed

- Quantitative objectives for quality and process performance are established and used as criteria in managing processes.
- Quantitative objectives are based on the needs of the customer, end users, organization, and process implementers
  - Quality and process performance are understood in statistical terms and are managed throughout the life of the processes
  - Subprocesses are selected that significantly contribute to overall process performance

Maturity Level 4: Quantitatively Managed - 2

- Special causes of process variation are identified and, where appropriate, the sources of special causes are corrected to prevent future occurrences
- Quality and process performance measures are incorporated into the organization's measurement repository to support fact-based decision making in the future
- The performance of processes is controlled using statistical and other quantitative techniques
  - At maturity level 3, processes are only qualitatively predictable.

Quantitative Project Management

- Quantitative Management is tied to the organization’s strategic goals for product quality, service quality, and process performance
- When higher degrees of quality and performance are demanded, the organization and projects must determine if they have the ability to improve the necessary processes to satisfy the increased demands
- Achieving the necessary quality and process performance objectives requires stabilizing the processes or subprocesses that contribute most to the achievement of the objectives and reducing process variation to support the quantitative management objectives.

Process and Product Performance

- Process performance is a measure of the actual process results achieved
- Process performance is characterized by both process measures and product measures
- Process measures include:
  - Effort
  - Cycle time
  - Defect removal efficiency
- Product measures include:
  - Reliability
  - Defect density
  - Response time

Moving from Defined Processes to Quantitatively Managed Processes

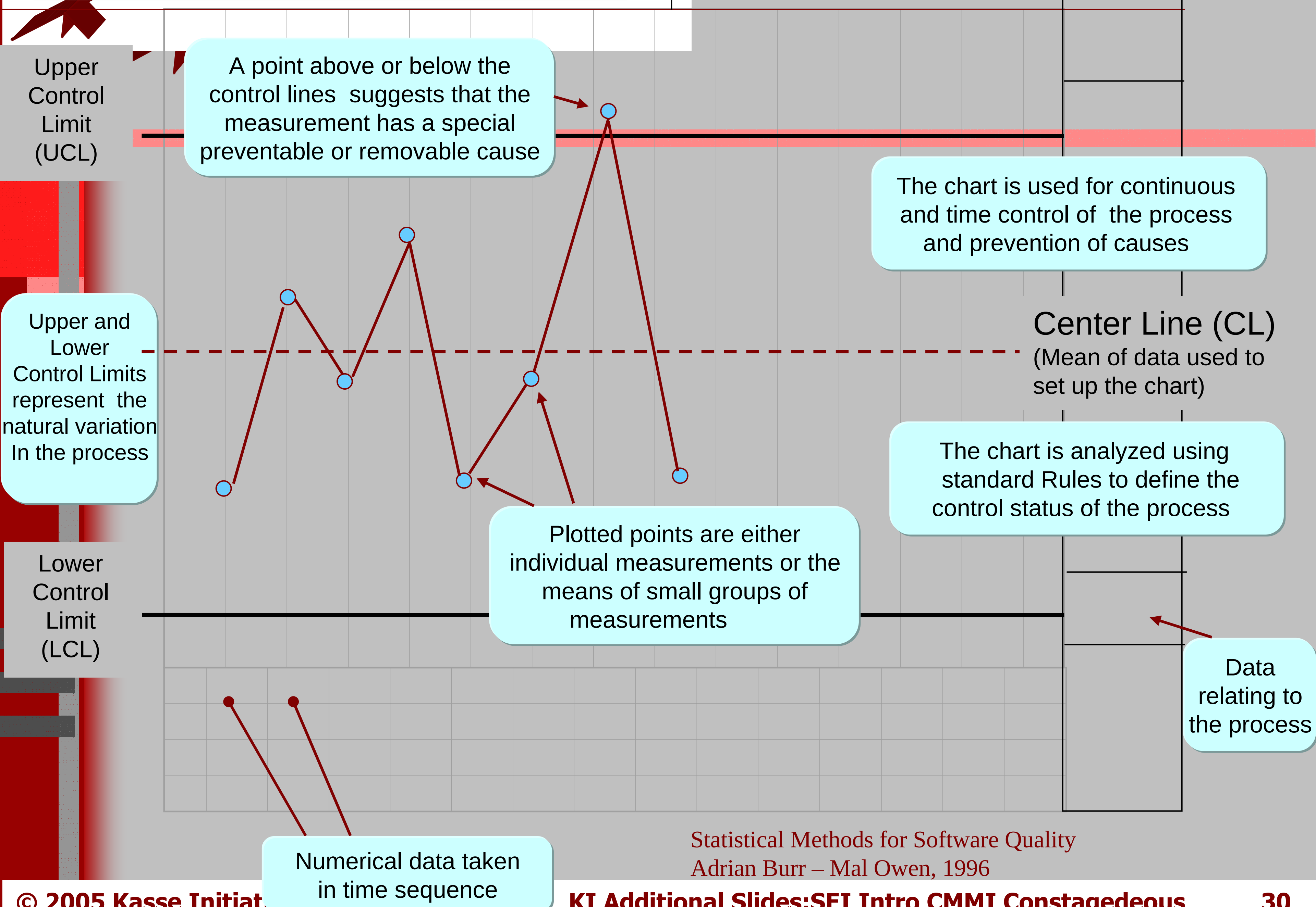
- With defined processes, measures are collected and analyzed to understand and manage activities and results:
  - Threshold limits are set, but not using statistical and other quantitative methods
  - Exceeding threshold limits triggers actions
- With quantitative management
  - Analyses are concerned with addressing special causes of process variation
  - Measurements are analyzed quantitatively to
    - Understand process performance
    - Predict the achievement of product quality and service quality objectives

Quantitative Tools

- There are a number of quantitative tools considered to be applicable to statistical process or quality control:
  - Quantifying and Predicting Process Performance
    - Control Charts
    - Histograms
    - Run charts
  - Cause and Effect Relationships
    - Scatter diagrams
    - Cause-and-effect (fishbone) diagrams
    - Bar charts
    - Pareto charts
    - Interrelationship Diagraph
    - Kiviat Diagram

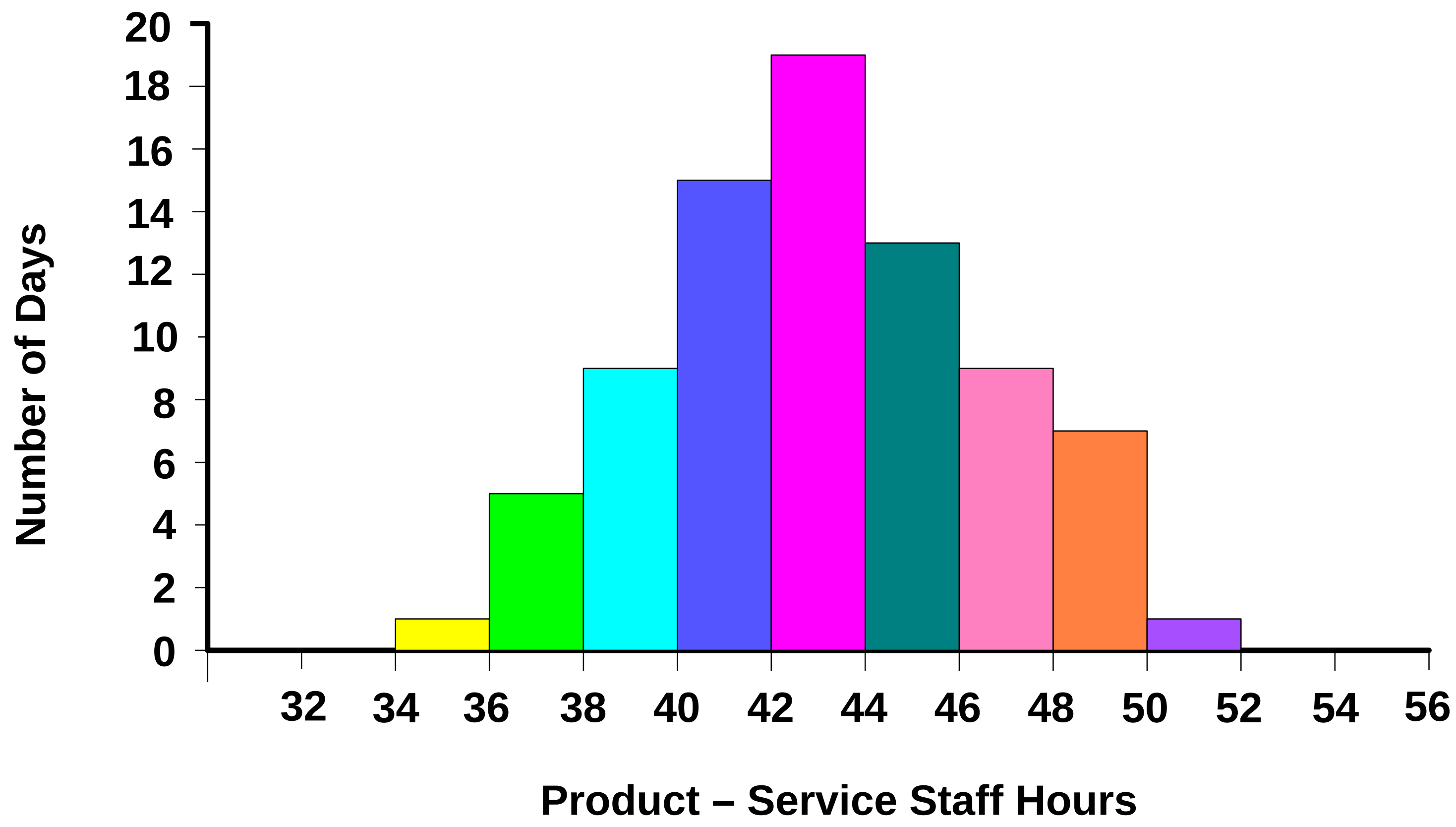
PROCESS CONTROL CHART TYPE:

METRIC:



Statistical Methods for Software Quality
Adrian Burr – Mal Owen, 1996

Histogram



20
18
16
14
12
10
8
6
4
2
0
Number of Days
32
34
36
38
40
42
44
46
48
50
52
54
56
Product – Service Staff Hours

Quantitative Project Management Concepts References

- Some sources that can help to really understand what is behind this statistical process control are:
  - Understanding Variation by Donald Wheeler
  - Statistical Methods for Software Quality by Adrian Burr and Mal Owen
  - Measuring the Software Process by William Florac and Anita Carleton.

Voice of the Customer

Process Capability

- Process capability is analyzed for those subprocesses and those measured attributes for which objectives have been set
- A capable process is one that is satisfying its quality and process performance objectives and can be expected to satisfy those objectives in the future

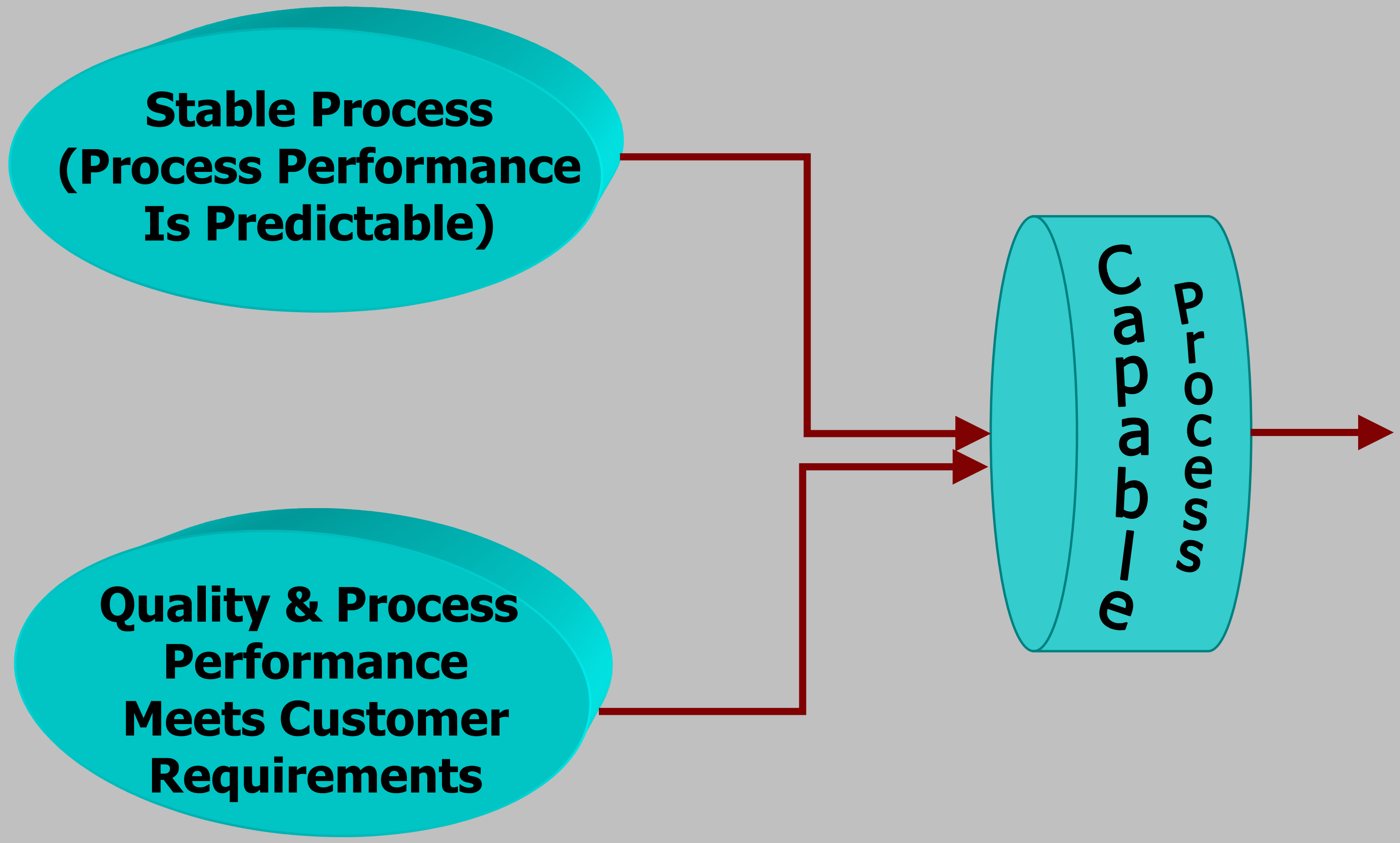
Voice of the Process

- Voice of the Process
  - The natural bounds and variation within those bounds of process performance
    - variation is within 3σ of the process mean
    - process is stable and does not exhibit any unlikely patterns or events

Voice of the Customer

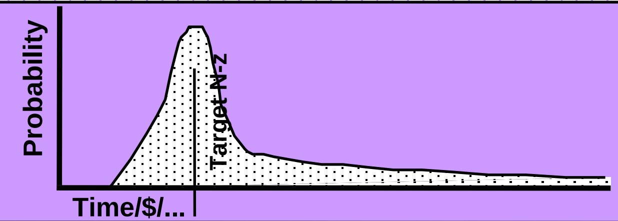
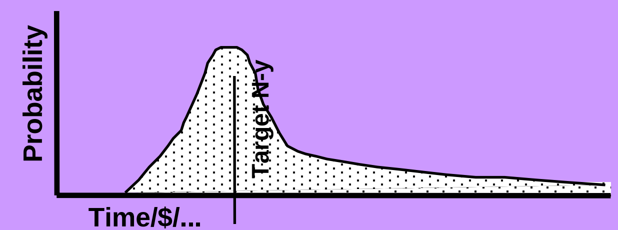
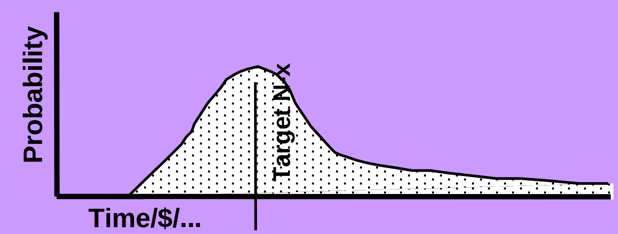
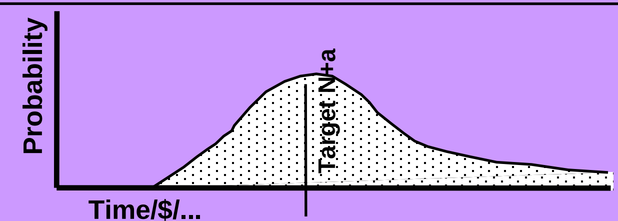
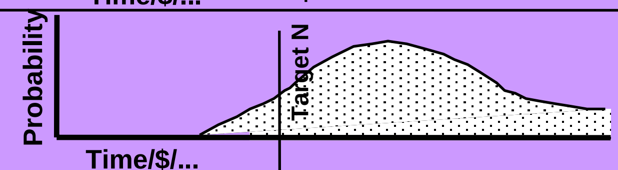
- Voice of the Customer
  - The goals established for the product and process performance
    - product specifications
      - amount of downtime
      - mean time to failure
      - response time
    - management specifications
      - meeting the schedule
      - meeting the budget

Capable Processes



Summary

Process Capability Prediction

Level	Process Characteristics	Predicted Performance
5 Optimizing	Focus is on continuous quantitative improvement	
4 Quantitatively Managed	Process is measured and controlled	
3 Defined	Process is characterized for the organization and is proactive	
2 Managed	Process is characterized for projects and is often reactive	
1 Initial	Process is unpredictable, poorly controlled, and reactive	

Summary

- The Process Capability Prediction figure provides a “process capability prediction” view of the CMMI and illustrates the theme of reduction of variation
- **Initial** level - target dates of cost, schedule, performance and quality are often missed by wide variation.
- **Managed** level - the variability of the actual results around the target decreases.
- **Defined** level - variability again decreases.
  - Target hits increase and the
  - Target begins to move in toward the Y-axis due to reduced rework.
- **Quantitatively Managed** level - variability continues to decrease.
  - Target results improve,
  - Development time becomes shorter
  - Productivity and quality increase.
- **Optimizing** level - defect prevention helps to reduce rework further and variation continues to be reduced.

Summary - 2

- There are also many different ways that the CMMI can help an organization that are not always obvious on the surface
- *Helping an organization to reduce variation as it improves in its process capability is a benefit of using the CMMI that all organizations should strive to utilize*

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Sound Systems Engineering using CMMI®

Michael T. Kutch, Jr.

Director Engineering Operations, Code 09K

Chief Engineer Code 70E

Intelligence & Information Warfare Systems Department

SPAWAR Systems Center Charleston (SSC-C)

Sandee Guidry

SEI Authorized CMMI Lead Appraiser

SEI Authorized CMMI Trainer

Technical Software Services, Inc.

Engineering Process Office

SPAWAR Systems Center Charleston (SSC-C)

NDIA CMMI Technology Conference, November 17, 2005

N65236-ENGOPS-BRIEF-0014-1.0

Systems Center Charleston

Presentation Outline

- Introduction
- Revitalization Effort using CMMI®
- Training
- Summary

Introduction to SSC-Charleston

Systems Center Charleston

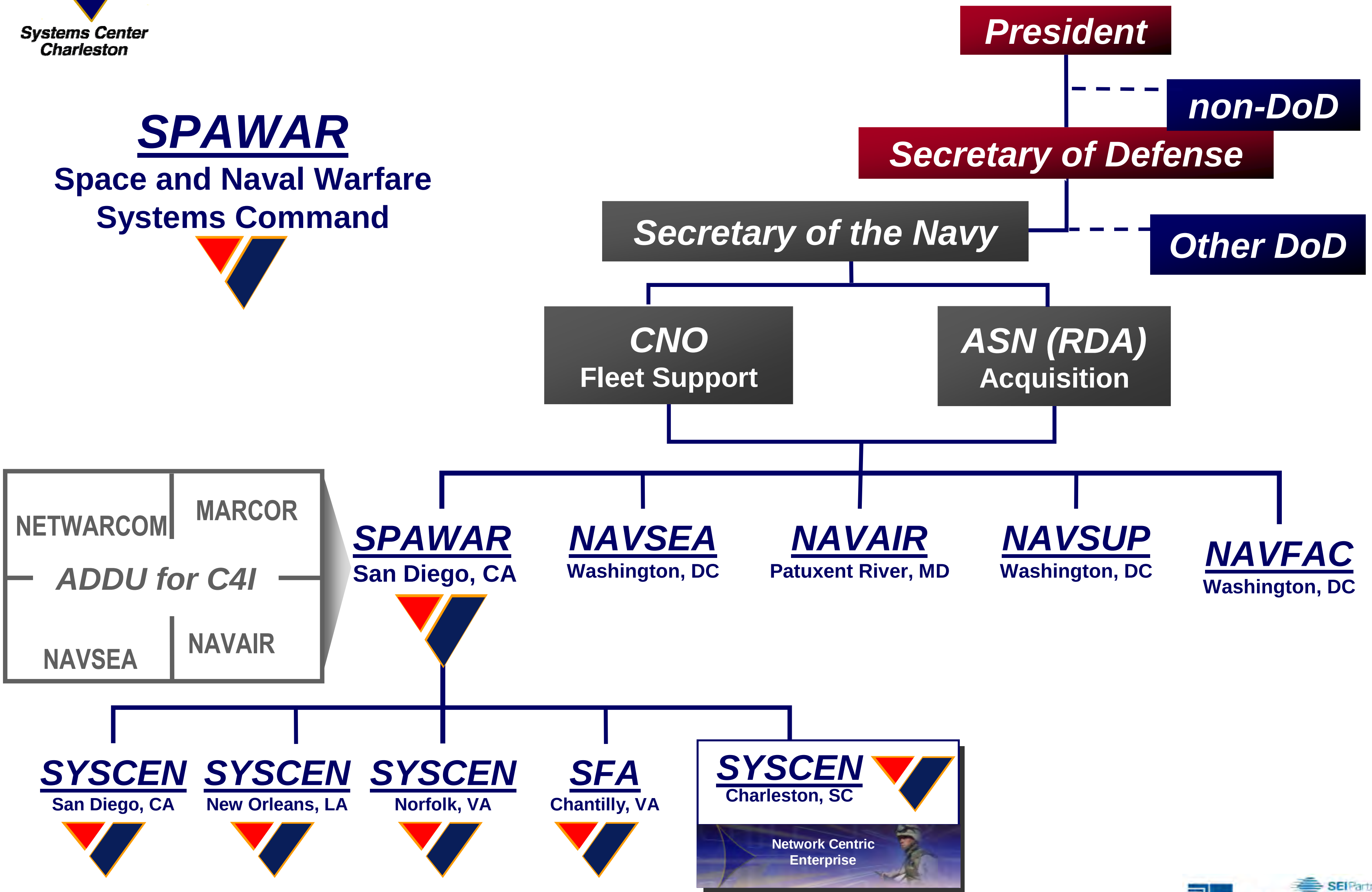
- Where we fit
- What we do
- What we are known for
- Who we are

Systems Center Charleston

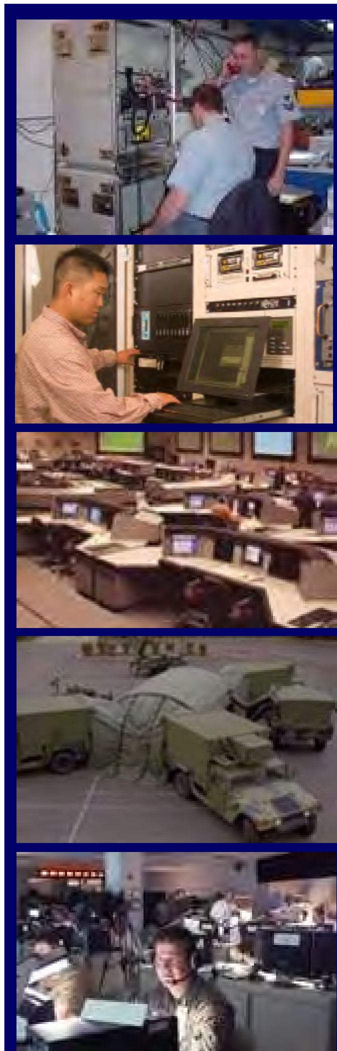
Where We Fit

SPAWAR

Space and Naval Warfare Systems Command



What We Do



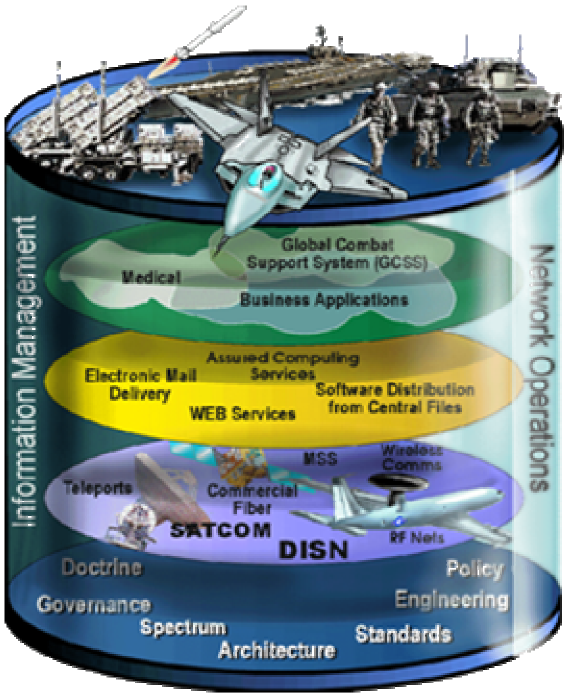
C4ISR

- **C**ommand
- **C**ontrol
- **C**ommunications
- **C**omputers
- **I**ntelligence
- **S**urveillance &
- **R**econnaissance

- ***Modeling & Simulation***
- ***Command & Control***
- ***Navigation***
- ***Physical & Computer Security***
- ***Video Teleconferencing***
- ***Information Assurance***
- ***Sensors***
- ***Communications***
- ***Cryptologic & Intelligence***
- ***Image Processing***
- ***Meteorology***
- ***Air Traffic Control***

What We're Known For

- **Developer of FORCEnet joint collaborative assessment tools** that promote netCentric interoperability and reduce system redundancy
- **Principal SPAWAR provider for Joint and Homeland Security** C4I solutions in a responsive manner.
- **Navy's most efficient provider of critical engineering** and acquisition expertise for Navy/Joint commands and other federal agencies

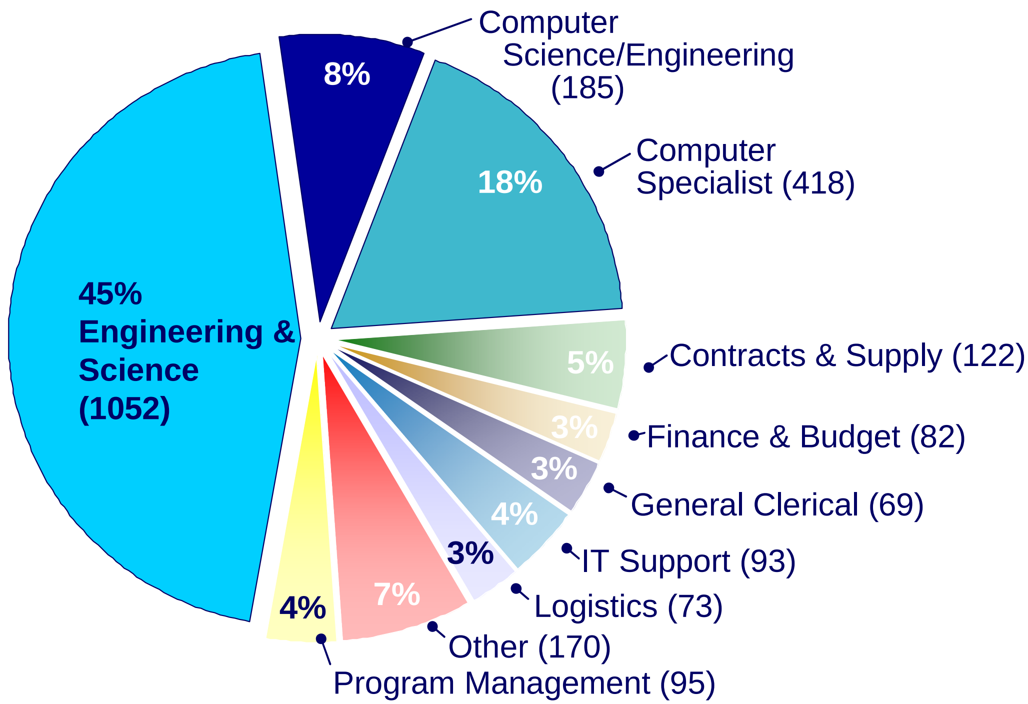


- **Rapid integrator and deployer of interoperable technologies** to the Navy, Federal Government, and Joint Warfighter
- **Developer and employer of life-cycle logistic support solutions** in a web-enabled portal environment

Systems Center Charleston

A Large Systems & Software Engineering Organization

Over 70% of workforce is in an engineering or computer-related discipline



- The effective and efficient solutions to the global war on terror developed by SPAWAR result from good systems and software engineering.
- Systems engineering is our core competency.
- Total workforce of ~ 2300 employees.

TECHSOFT Technical Software Services, Inc.

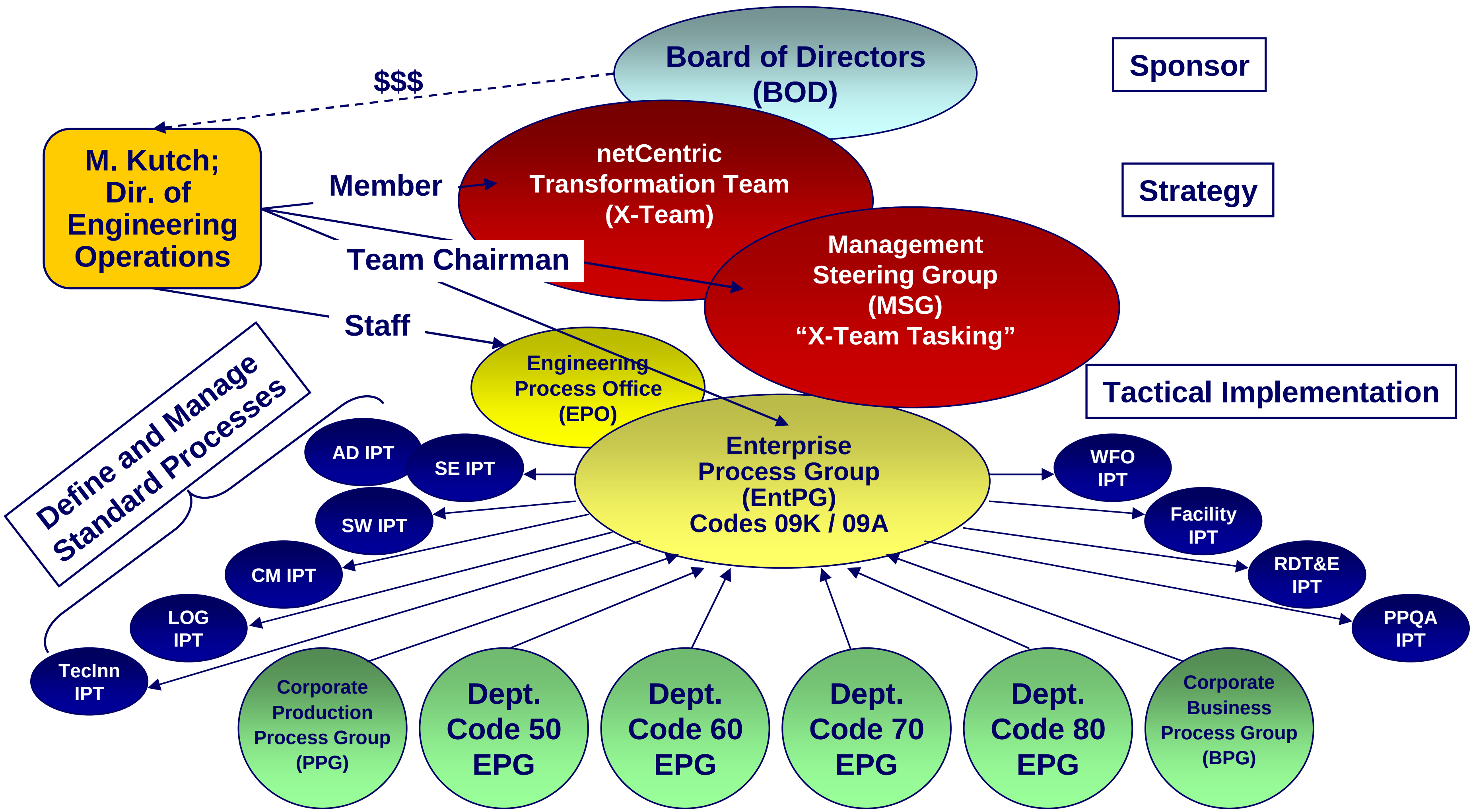
SE Revitalization Effort using CMMI®

- Vision
- Organization
- Plan
- Process
- Tool

Vision

- **Vision**
  – Develop and maintain a World Class Systems Engineering Organization
- **Approach**
  – Achieve Command-wide operational consistency
  – Based on ISO/IEC 15288 – systems engineering
  – Based on ISO/IEC 12207 – software engineering
  – Based on implementing CMMI® “Staged Respresentation”
  – Measure using best practices of CMMI® “Continuous Representation”
- **Benefits**
  – Facilitates sharing of tools, documentation, templates, and other artifacts needed by project engineers
  – Project Engineers will implement projects quicker; with improved monitoring, effectiveness, quality and efficiency

Organization for Implementation



SSC-C SE Revitalization Plan

Elements of SSC-C SE Revitalization

Policy / Guidance

- DoD SE Guidance & SE Instruction 54xx.1
- SSC-C SE Process Manual
- SSC-C SW Process Manual
- ePlan Builder

Training / Education

- Intro to PI WBT
- SE 101 WBT
- SE Fundamentals
- SW Fundamentals
- Certification Program

Assessment & Support

- CMMI® Level 2
- CMMI® Level 3
- Integrated Product Teams
- SITC - Tools
- Lean Six Sigma

Underway

Completed/Ongoing

Basis for SSC-C SE Process

Systems Center Charleston

SSC-C Systems Engineering Process

SSC-C Software Engineering Process

Measure & Assess Processes

CMMI® for SE/SW

FORCEnet
SPAWAR Instruction 54xx.1
SPAWAR SE-FCL

SPAWAR Guidance

ISO/IEC 15288
System Life-Cycle Processes

ISO/IEC 12207
Software Life-Cycle Processes

Industry Process Standards

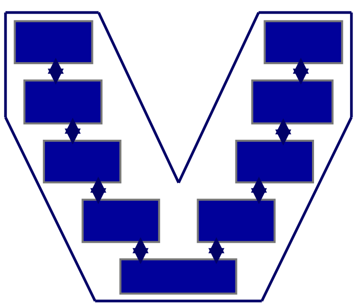
Industry References	DoD References
INCOSE	GIG / Net-Centric Strategy
PMBOK/SWEBOK	CJCS-JCIDS 3170.01
IEEE	DoD Architecture Framework
EIA 632	SECNAV 5000.2C
ISO 9001:2000 Quality Systems	DoD 5000.1/5000.2

SSC-Charleston SE Process Steps

- Process Implementation
- Stakeholders Requirements Definition
- System Requirements Analysis
- System Architectural Design
- Implementation
- Integration
- Verification
- Transition
- Validation

Key Milestones

- System Requirements Review (SRR)
- System Design Review (SDR)
- Test Readiness Review (TRR)



Follows SE "Vee"

Each process step is defined by required inputs, controls, associated processes, and outputs.

Adapted from "SSC-C Systems Engineering Process Manual"

ePlan Builder Tool

Systems Center Charleston

- **ePlan Builder tool**
  - An interactive, web-based application that leads the user through a structured interview process (like TurboTax) to generate a CMMI®-compliant plan
  - Includes standard, consistent text
  - Generates a complete Project Management Plan, Configuration Management Plan, Quality Assurance Plan, and Requirements Management Plan
  - Future versions will build
    - Systems Engineering Plan
    - Measurement and Analysis Plan
    - Supplier Agreement Management Plan

Training

- Process Improvement and CMMI®
- Systems/Software Engineering Classroom
- Web Based Training (WBTs)

Process Improvement Training

Systems Center Charleston

- **Intro to Process Improvement**
  - Over 800 people trained
  - Provided via WBT
  - Now Mandatory for all employees
- **CMMI®**
  - SEI's Intro to CMMI® course onsite
  - SSC-C Level 2 Processes
  - 875 people trained
- **Project Management/Project Monitoring & Control**
  - 625 people trained
- **Process-specific Workshops (CM, QA, REQ, M&A)**
  - 375 people trained

Over 1300 Individuals Trained

Total attendance over 2800 *

**** This accounts for some employees attending more than one course***

Systems Engineering Fundamentals Classes

- **3-day on-site, classroom course**
  - Based on SMU SE Masters course
  - Customized to incorporate SSC-C SE process
  - 180 SSC-C engineers trained
  - Classes planned every 2 months
- **1-day *SE for Managers* course added**
- ***Intro to Software Engineering* planned**

“The course was very educational. It helped me relate my current project to the overall system it was a part of, and how it fits in with the big picture.”

“The course was well presented and accurately covered the Systems Engineering Design Process Fundamentals. Continued/additional training on this subject is critically needed for this command to continue to develop as a professional engineering organization.”

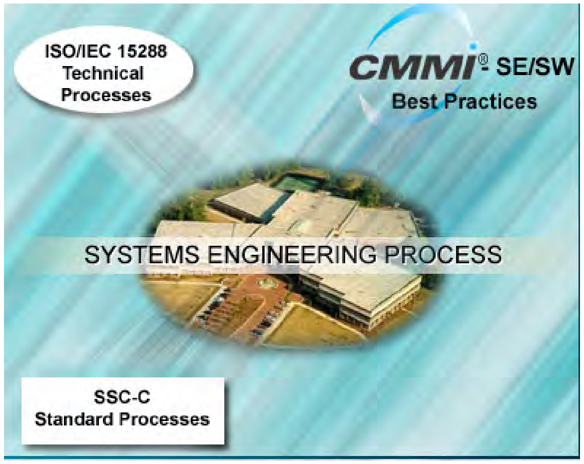
Student Feedback

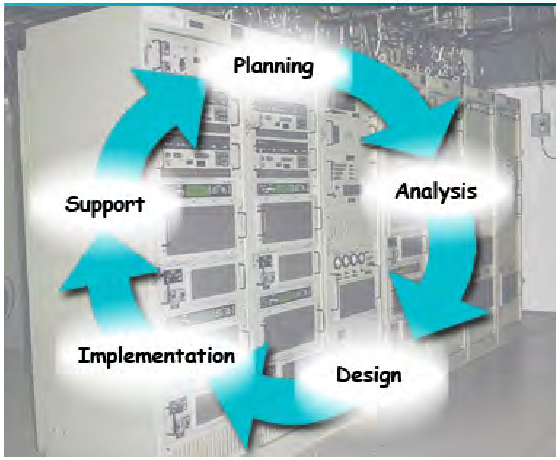
PI Web Based Training

To offer Process Improvement training to more employees, we developed an on-line web based tutorial (PI-WBT) that allows students to take the course at their own pace and to receive a certificate and education credit upon course completion.

SEI Partner
TECHSOFT
Technical Software Services, Inc.

- **Introduction to Systems Engineering**
  - 10-module web based training
  - Closely aligned to SSC-C SE Process, SE Fundamentals Course, ISO/IEC 15288 and IEEE standards
  - Includes hotlinks to referenced documentation
    - Process manuals, policies, standards





Summary

- Accomplishments
- Results and Measures
- Lessons Learned
- Going Forward

What We Have Accomplished

- **Process Focus**
  - Defined Policies and Processes
  - Aligned with DoD and SPAWAR guidance
  - Aligned with industry standards and CMMI® model
  - Built organization structured around processes and process improvement
- **Training is Critical**
  - Providing Fundamentals of Engineering for new and old professionals
  - Developed web-based training for "self-paced" and refresher training
  - Defining a structured technical career development path for engineers
- **Tools for the Engineers**
  - Developed *ePlan Builder* application to generate planning documents
  - Developed templates, checklists, and web-based document repositories to link standards and DoD guidance to day-to-day tasks and processes

Early and persistent Systems and Software Engineering applied to programs and projects

Results and Measures

- **Formal process improvement policy issued in 2003**
  - Use CMMI® to evaluate progress against best practices
- **Selected pilot projects**
  - Training of project teams
- **Informal Appraisals, Process Reviews, and Document Reviews to measure progress and identify gaps**
  - Class B/C appraisals of selected projects
  - Define/review project-specific plans and procedures
  - Ensure the processes and procedures were used
- **Project-level Formal SCAMPI℠ Appraisals (Class A)**
  - Evaluated compliance with CMMI ® Maturity Level 2 requirements
  - 8 projects appraised between June 2004 and February 2005
- **Command-wide appraisal in April, 2005**

Major Milestone – Maturity Level 2

- **The first SPAWAR Systems Center to achieve CMMI® Maturity Level 2 at the command level**

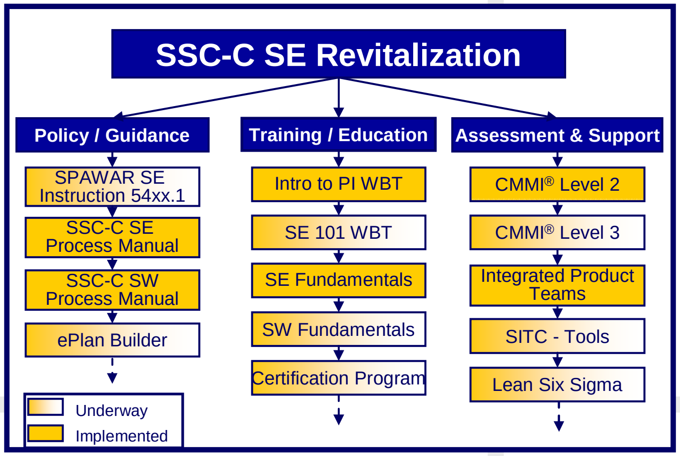
Systems Center Charleston

Lessons Learned

- **Senior Management support is critical to success**
- **Training**
  - Everyone needs to be engaged – “train the masses”
  - Specific training for process owners/subject matter experts
- **Utilize Teams (IPTs) as champions of specific processes**
  - Multi-department representation
  - Change agent mentality
  - Process focused charters
- **Resource Properly**
  - Implement with projects that want to improve, can benefit from efforts, and that recognize own weaknesses
  - EPO staff provided skilled coaching, resources, support, and tools
  - Project members learned by doing and maintaining
- **Goals and Publicity**
  - Keep goals to sizable bites (projects)
  - Publicize successes; Share best practices

Summary

- **Aggressive SE Program**
- **Industry Standards**
  - Systems Engineering (SE)
  - Software Engineering (SW)
- **Best Practices**
  - CMMI®
  - ISO 9001
  - Lean Six Sigma



- **Training – 1,300 people***
- **Systems Engineering Fundamentals - 180**
- **Intro to SSC-C PI**
  - CMMI® Level 2 Processes
  - CMMI® Level 3 Processes
  - SE/SW Engineering Workshops
  - Web-Based Training (WBT) for Process Improvement

*includes industry partners

- **Successes**
  - Command Achieved CMMI® Maturity Level 2 in April 2005
  - 1st SPAWAR Systems Center to Achieve CMMI® Maturity Level 2

SPAWAR Systems Center Charleston 2 World Class Systems Engineering Capability Maturity Model Integration (CMMI) MATURITY LEVEL April 28, 2005

- **Plans**
  - World Class Systems Engineering
  - Support Command Balanced Scorecard
  - April 2007 CMMI® Maturity Level 3

CMMI SM

Going Forward

- **Develop more “how to …” guidance and tools**
  - ePlan Builder, an interactive web application, helps build required plans.
    - Currently builds PMP, QA, Configuration Mgmt, and Requirements Mgmt plan
    - Systems Engineering Plan, Measurement & Analysis Plan, and Supplier Agreement Management Plans under development
  - Institutionalize the SE/SW processes
    - Emphasize Formal Reviews
- **IPTs - expanding beyond CMMI® & Engineering areas**
  - Expecting more integration from teams
- **CMMI®**
  - SSC-Charleston standard process with Tailoring Guidelines for all projects
  - Projects progressing to ML3
  - Process Improvement tracked at department/project level using self assessment tool
  - 2 Balanced Scorecard measures directly related to CMMI®

SPAWAR
Systems Center
Charleston

Thank you !

Any Questions ?

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TECHSOFT
Technical Software Services, Inc.
SEI Partner

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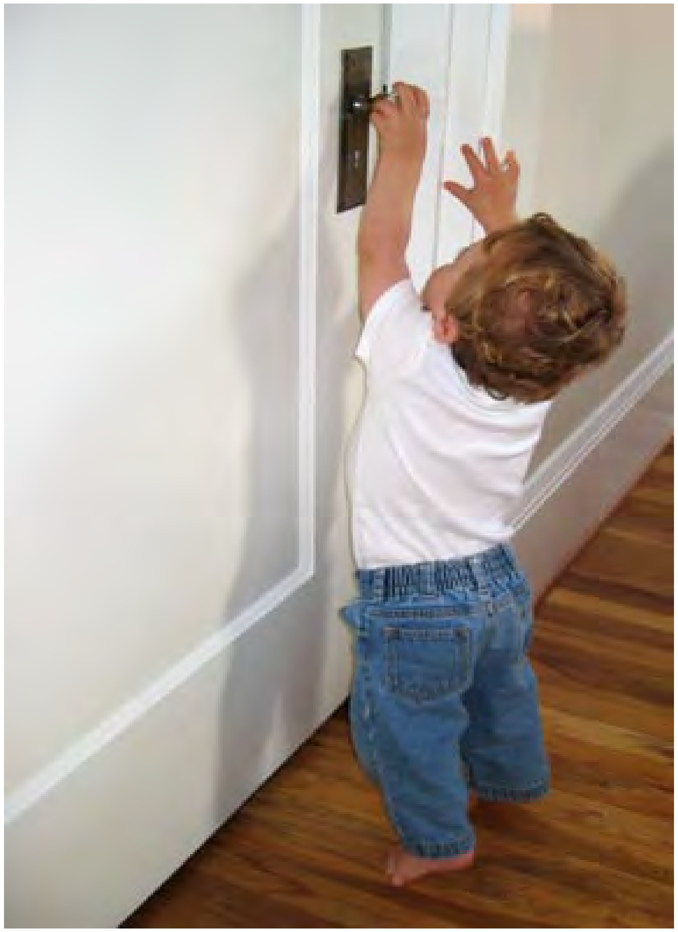
What Goes On Behind Closed Doors



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or How To Get The Appraisal Team To Say...

Perception vs. Reality?

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Missile Systems

Perception – Appraisers do everything in their power to find that one little thing that ensures that the organization will fail to meet it's goal

Reality – Appraisers really do WANT the organization to achieve their CMMI goal.

It is up to the organization to build confidence in the appraisal team that their process definition and execution meets the goals of the Capability Maturity Model Integration (CMMI)

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So, How Is This Done?

So, How Is This Done?

- Assemble the “correct” Appraisal Team
- Be prepared!
- Form the mindset from the beginning
- Have a consistent story
- Enable the appraisal team to do their job
- Make it hard for the appraisal team to say 
- Don’t surprise the appraisal team during the SCAMPI

Assemble the “correct” Appraisal Team

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- Choose the right Appraisal Team Lead
  - See “Used Cars and Lead Appraisers” (by Tim and Tom)

- Ensure correct Appraisal Team Knowledge and Skills
  - Good mix of discipline and functional expertise
  - Balance Insider/Outsider membership on the team
  - Monitor team dynamics

- Keep the Appraisal Team Together
  - Focus Process Area responsibilities
  - Can’t please everybody all the time, so please the appraisal team

Be Prepared!

- Be committed and show that commitment
- Ensure evidence collection is complete, concise and adequately organized
  - Provide detailed mapping, pointers, and comments
- Scrub evidence for relevance and sufficiency
  - Quantity is not quality.
  - In fact, quantity usually means late nights and VERY grumpy appraisers!!
- Prepare Participants
  - Get ready for the face to face interviews, information requests, follow-up interviews, preliminary observations

The Appraisal Team should be verifying not discovering

Form the Mindset From the Beginning

- Demonstrate an understanding of the model and appraisal methodology
  - Appraisal Planning (scope, model representation, and schedule)

- Create a collaborate environment
  - Foster a win/win relationship

- Schedule and Conduct Intermediate Reviews with Realistic Goals
  - Class Cs, Class Bs, Internal Readiness Reviews, SCAMPI
  - Goals must be consistent with the type of review
  - Don’t forget “Should-to-Shoulder” reviews
    - See “Wasted Days and Wasted Nights” (by Tim and Tom)

Raytheon
Missile Systems

Have a Consistent Story

- Paint a story with the evidence:
  – The Appraisal Team is not clairvoyant and needs the story presented clearly through the evidence
  – Weave a thread through and across the process areas
  – Use the same piece of evidence for multiple practices

- Site Brief
  – TELL how your processes and programs satisfy the CMMI
  – Get credit for as much “affirmation” as possible

- Interviews
  – TELL how your processes and programs satisfy the CMMI
  – Appraisal Team needs to “hear” what was seen

Evidence should substantiate the site brief
Interviews should reinforce the evidence

Enable the Appraisal Team to Do Their Job

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- Have dedicated facilities for the team
- Verify tools and networking are working
  - have a back-up plan
- Appraisal schedule must be adhered to by all involved
- Have evidence collected, inventoried, and VERIFIED!
- Do not burden the Appraisal Team with 40 pieces of evidence if 3 will adequately tell the story
- Have sufficient resources to respond quickly to information requests and follow up interviews

Make It Hard for the Team to Say

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Missile Systems

- Stick with the same, or a core set of, Appraisal Team members
- Use Appraisal Team as consultants up to the SCAMPI
- Lead the Appraisal Team to the answer
  - Map the evidence to the practices of the model, have detailed pointers
  - Use clear and concise comments to help the appraiser understand why the evidence is relevant to that practice
- Reinforce evidence with the Site Brief and Interviews – tell the same story
- Have a Demo if it helps tell the story

Don’t Surprise the Appraisal Team During the SCAMPI

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Missile Systems

- Do not use the SCAMPI to validate alternative approaches
  - Use the Intermediate Reviews to gain concurrence
- The SCAMPI should be little more than a rubber stamp
  - The only new evidence the Appraisal Team should see is to address prior weaknesses
- Remember the confidentiality agreement
  - Don’t badger the Appraisal Team with “How Are We Doing?”

Questions

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Team of Three

How to get Program, Functional, and Process Management Working Together

Raytheon Missile Systems
Mark Marsh and Lety Santillan

November 16, 2005

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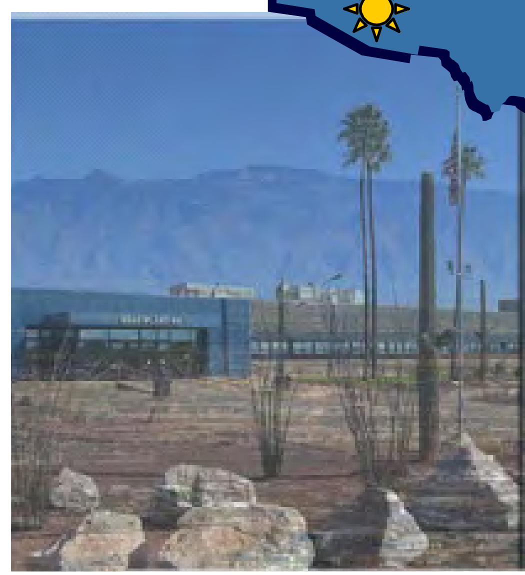
Organization and Accomplishments

Raytheon Missile Systems, Headquarters Tucson, AZ

- Employees: 11,000
- ’04 Sales: $3.8 B
- World Largest Appraised SEI CMMI Level 3 Organization December 2004
- SW-CMM Level 5 in November 2001



RMS Approach to MA

- Analyzed the PBA findings and created a work plan
- Benchmarked against other CMMI Level 3 Raytheon Organizations
- Conducted peer review of Organizational MA Plan
- Conducted Several focus groups
  - Program Management
  - Functional Organizations
  - CMMI Experts
  - Six Sigma Experts
- Concluded Template approach best
- Team of Three concept is born
- Measurement Analysis could cover more

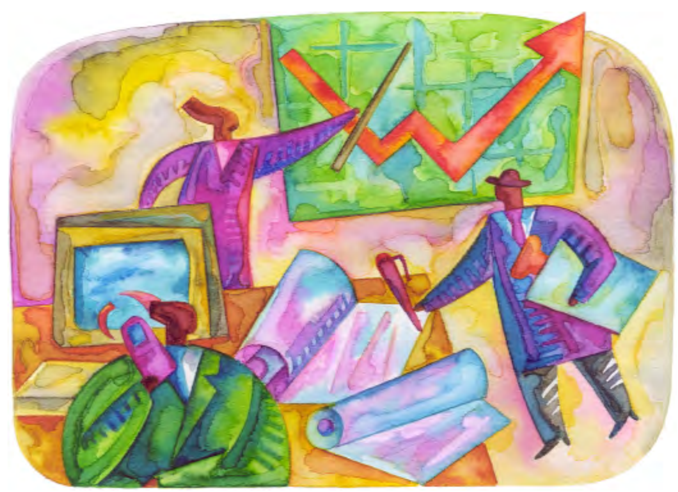
Overview of M&A Process

- The purpose of Measurement and Analysis at RMS: **The Measurement and Analysis (M&A) process is intended to provide information to the projects to make informed decisions to minimize risk and ensure project success while helping to support the overall organization's business objectives.**

- The purpose of Measurement and Analysis in CMMI: **The purpose of Measurement and Analysis is to develop and sustain a measurement capability that is used to support management information needs.**

How the Right Measures Help Teams Excel- Harvard Business Review

- The overarching purpose of a measurement system should be to help a team, rather than top managers, gauge its progress.
- A truly empowered team must play the lead role in designing its own measurement system.
- Because a team is responsible for a value-delivery process that cuts across several functions (like product development, order fulfillment, or customer service), it must create measures to track that process.
- A team should adopt only a handful of measures.



What did RMS do?

- Created a series of workshops with Program Management
  - Brought to the table the critical success factors, contractual requirements and lessons learned from previous programs
  - Program Management Team took first cut at what goals, information needs and measurements objectives for the program were.
  - Once these items were determined then metrics were selected
  - Program management would then lead a workshop with IPT Leads to go over selections get buy-in from IPT Leads
  - Once the program management and IPT Leads agreed on the metrics the process was repeated with the metric collection points
  - Functional and process representatives were selected by program team

Process Improvement Requires Synergy between Organization and Programs

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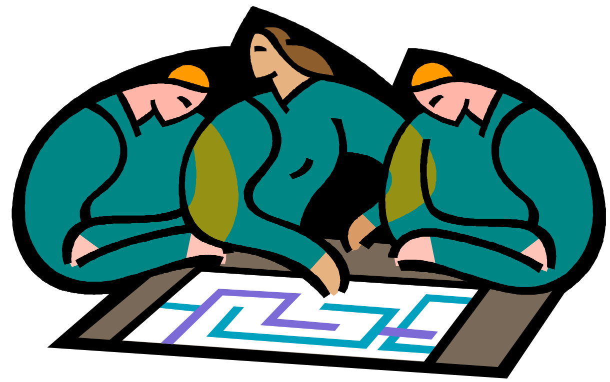
- To achieve high levels of process maturity, the organization and programs must work closely together
  - **New process at the organization level need to be deployed to programs**
  - **Best practices and lessons learned from the program levels must be flowed to the organization and shared across programs**
  - **Quantitative management activities need infrastructure to facilitate metrics collection and analysis**

Team of Three (ToT) Concept

- Team of Four and Team of X concept successful at other Raytheon sites
- Adopted the concept at RMS in 2004
- Consistent with integrated product team approach
- Very effective mechanism for process improvement



Vehicle for programs to make informed decisions and ensure program success while helping to support the overall organization's business objectives

What is a Team of Three (ToT)?

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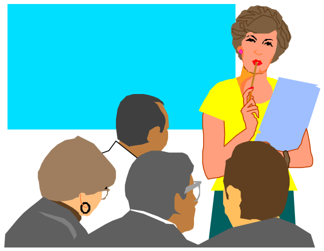
- A team that supports the program with process deployment and analysis
  - Team goal is to help ensure project success while helping the organization improve over time
  - The team members bring a broad perspective, can better facilitate sharing across projects and help the organization improve as a whole
  - In the spirit of Integrated Product Teams (IPT)
- Also the primary mechanism for process deployment activities on projects
  - Supports the organization's process improvement efforts
- Should not impede Program

Team of Three Members

- Each Team of Three (ToT) consists of (as a minimum):
  - Program Representative: (“Chair”) Program Manager, Chief Engineer, or a Senior Integrated Product Team Lead
  - Functional Manager (FM)
    - ❑Typically a Department Manager (DM)
    - ❑Systems, “Integration Test &Analysis” are the two primary functional organizations
    - ❑Radar, Configuration Management, and other Centers can participate
  - Process Representative: R6Sigma Expert or IPDS@RMS Expert
- Additional representatives may attend as needed (from the program or other organizations):
  - Data Management
  - Quality
  - Supply Chain Management



Working as a Team Contributes to Program Success

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Team-of-Three

- **Improved Performance**

PROGRAM

- Responsibilities:
  - Chairperson
  - Financial
  - Technical
  - Programmatics
  - Process planning & implementation
  - Metrics collection & analysis

ENGINEERING MGMT

- Functional Management Responsibilities:
  - Project support
  - Resource provider (people, tools, training)
  - Team administration & facilitation
  - Process improvement
  - Cross-project knowledge

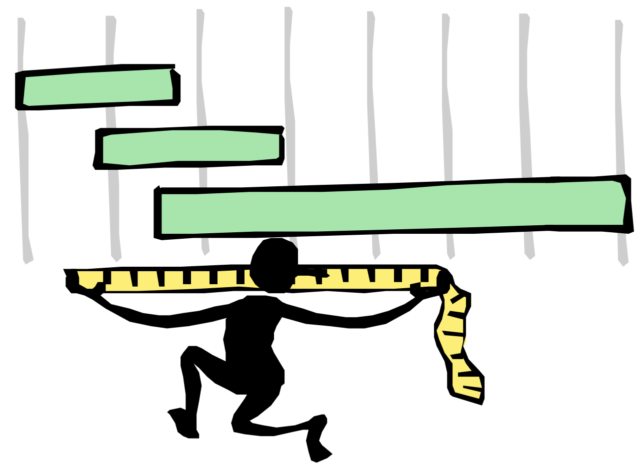
PROCESS

- Process Representative Responsibilities:
  - Project support
  - Process expertise & facilitation
  - Data Analysis skills
  - Lessons learned transfer
  - Best practices transfer
  - Process improvement
  - Cross-project knowledge

Team-of-3 Individual Responsibilities for
The Program Representative

Responsible for managing the activities for the program

- Provides the current project status and metrics to the ToT for analysis
- Implements the project's documented process, including adjustments and improvements
- Manages the project plans and process documents
- As chair of the ToT, facilitates team meetings and works to improve team effectiveness
- Ensures meeting minutes are documented and submitted to the Process Assets Library (PAL)
- Ensures documents are under configuration control



The Functional Manager

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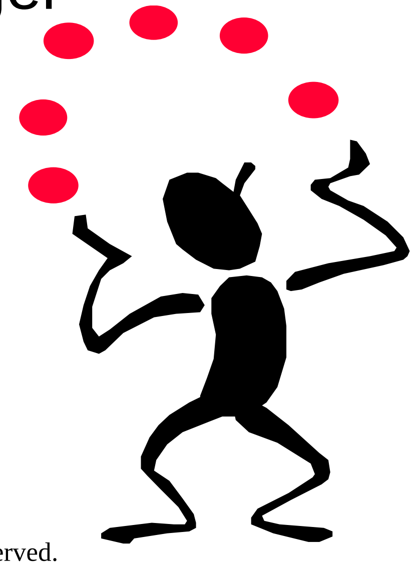
Responsible for providing adequate resources to the program in a timely manner

- Provides organizational resources to the project
  - Examples: trained staff, standard project tools
  - Good examples of "work products"
  - Not just their "home room" but advocate to all other functions
- Communicates organization goals and objectives
- Provides insight as a "higher level manager" has purview into multiple programs.



Team-of-3 Individual Responsibilities for
The Process Engineer

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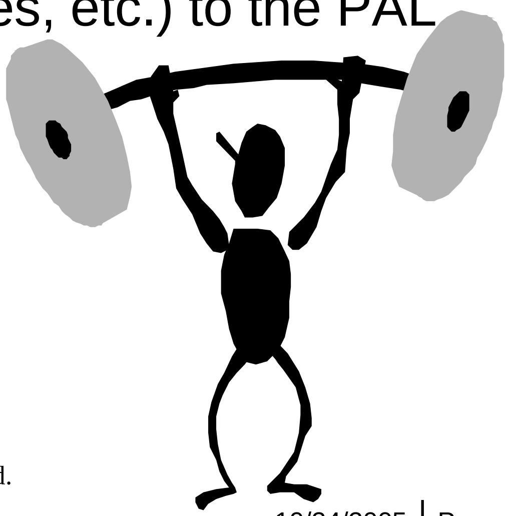
Supports process deployment

- Provides process deployment expertise and assistance
- Provides the organization with a vehicle for sharing lessons learned and process changes (when necessary and appropriate)
- Facilitates process-related problem resolution and process improvement efforts
- Assists with evidence/artifact collection and support of project evaluations
- Submits project data (lessons learned, best practices, etc.) to the PAL for use by other projects
- May assist program with preparation & review of project plans and process documents
  - Supplies process expertise
  - Makes process improvement recommendations
  - Ensures both organizational and project goals are considered in Tailoring Report



Team of Three

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Project Team of Three

Program –Program Manager and/or Chief Engineer or delegate (e.g. System IPT lead)
Functional - System Engineering and IT & A and Configuration Management Dept Mgrs/Section Mgrs
Process – R6Sigma Expert or IPDS expert

System Level

Functional Reviews

Dept Mgr
SEPG
SW Lead
Conf. Mgmt
SQE

Component Level

ToT Adds Value

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- Better visibility of key drivers (e.g., Productivity and other measures)
- Collaborative risk mitigation
- Timely resolution of issues (more proactive, less reactive)
- Eliminates wasted activities (no “reinventing the wheel”)

▪ **Improved Program Performance**

- Institutionalized processes
- In-Phase containment of defects
- Shared Lessons Learned and Best Practices

▪ **Improved Process/Product Quality**

Stronger Tie between Programs and Functional Organizations

More Successful IPTs

More Predictable Programs

ToT Process Improvement

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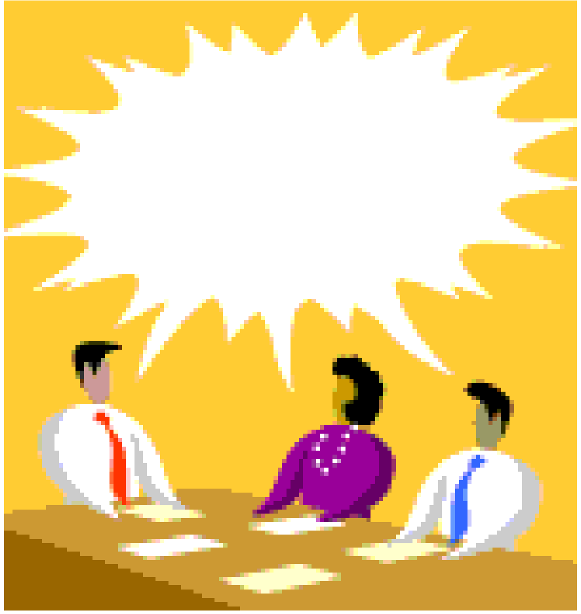
- Address activities identified in the program's process improvement plan
- Seek process improvements for areas identified in quantitative management
- Sponsor Process Action Teams on the program
- Identify lessons learned and best practices to share with rest of organization
- Review other programs lessons learned and best practices and determine if they should be applied to this program
- Prepare for appraisals, customer reviews, and audits



Organization Process Teams

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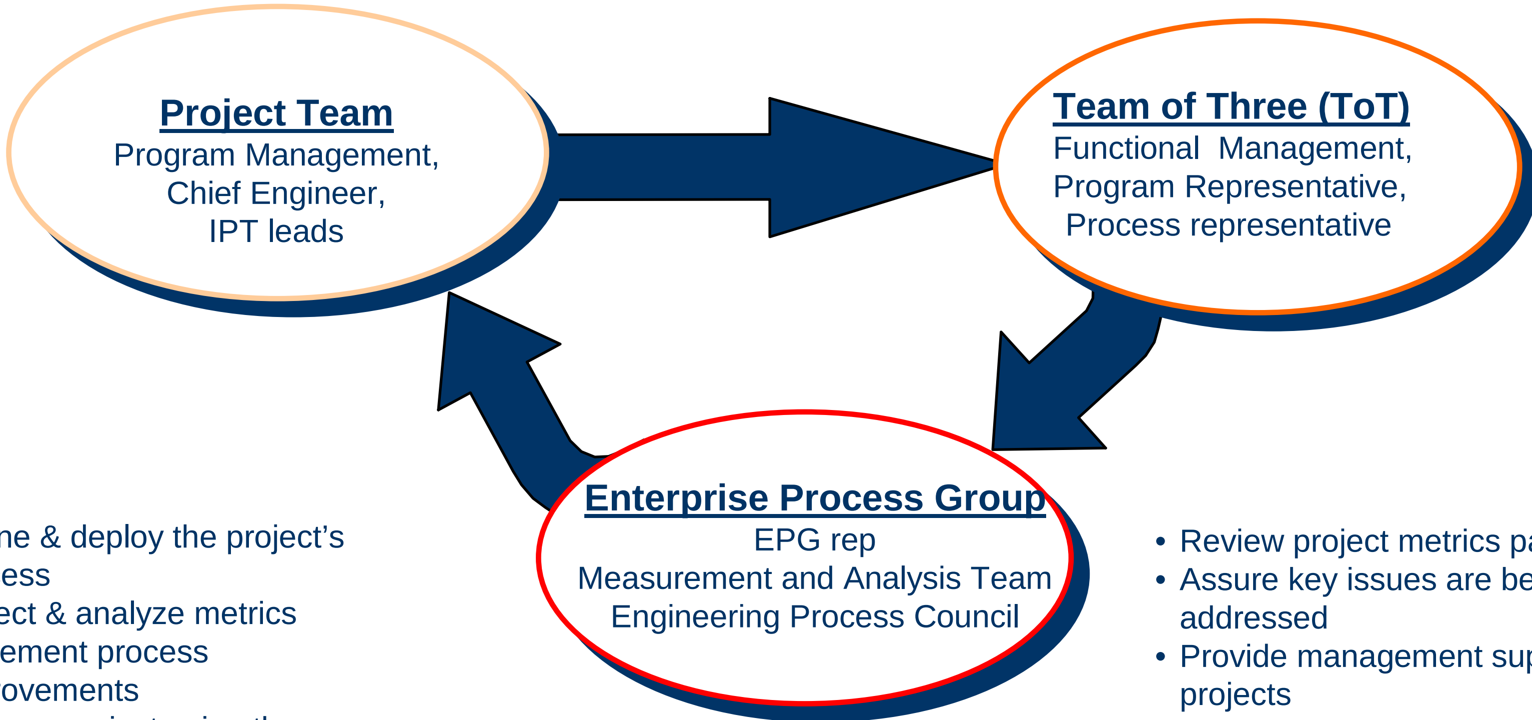

- Define & deploy the project's process
- Collect & analyze metrics
- Implement process improvements
- Manage project using the metrics
- Develop mitigation plans in response to unexpected results

- Analyze metrics for stability, trends & improvement opportunities (org, product line & project)
- Assign resources to key issues
- Assure compliance to process standards

- Review project metrics package
- Assure key issues are being addressed
- Provide management support to projects
- Publish IPR (sum of project's metrics packages)

Benefits of Effective Teams of Three

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- Improved process
  - Better tailoring and deployment
- Improved communication/collaboration
- More consistency across projects
- Shared lessons learned for use on other programs
- Better product quality
- Improved competitiveness
- Promotes higher maturity processes

"Working as a Team Fosters Program Success"

Why do all this?

- IPDS @ RMS provides an organizational plan and template on measures, monitoring and control, lessons learned, review of program and process data with a functional representative
- CMMI Level 3 looks for an organization process that has been deployed on the programs
  - Measurement Analysis is looking for a disciplined approach to metric selection ("goal-question-metric" philosophy)
  - Program Monitor and Control
  - Generic Practice 2.8 – Process Monitor and Control
  - GP 2.10 – Review Status with Higher Level Mgmt
  - GP 3.2 - Collect Improvement Information

Using the Team of Three for CMMI evidence

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- For Program evidence requirements, the Team of Three proved extremely useful.
- Each program was required to provide evidence for up to 15 different process areas.
- GP 2.8 Monitor and Control the Process
  - Monitor and control the measurement and analysis process against the plan for performing the process and take appropriate action.
  - GP 2.8 was satisfied (metrics package and minutes) in all 15 process areas.
- GP 2.10 Review Status with Higher Level Management
  - Review the activities, status, and results of the measurement and analysis process with higher level management and resolve issues.
  - Satisfied in 13 PA’s from Team of Three evidence.
- GP 3.2 Collect improvement Information
  - Collect work products, measures, measurement results, and improvement information derived from planning and performing the measurement and analysis process to support the future use and improvement of the organization’s processes and process assets.
  - Team of Three was a major contributor for GP 3.2 evidence in all PA’s.

Questions?

Thank you for your participation!

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A SCAMPI Data Review Improvement Technique

Getting The Big Picture
Without Pixelation

Kent McClurg
Aaron Clouse

Agenda

- Introduction
- Data Prep and Data Review Issues
- An Answer
  - Process Description
  - Results

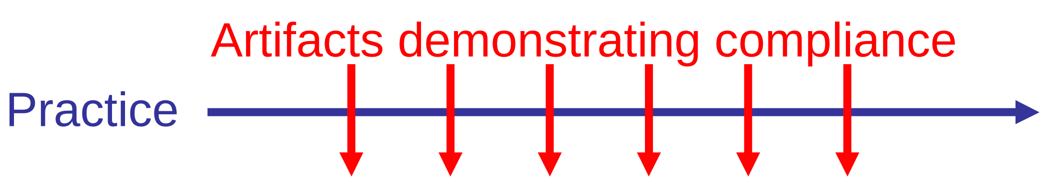
Introduction - 1

- This presentation focuses on issues associated with reviewing documents during a SCAMPI and a practical solution to resolving these issues.
  - Issue #1: The context of the applicable information is often not clear since the appraisal team member (ATM) does not have time to read the entire document or section of document in order to establish the context
  - Issue #2: Jumping from one document to another or from one section within a document to another section, in an attempt to determine that a practice is being satisfied is not very efficient.
- We will explore an approach that you may find improves your appraisal performance significantly.

Issues - 1

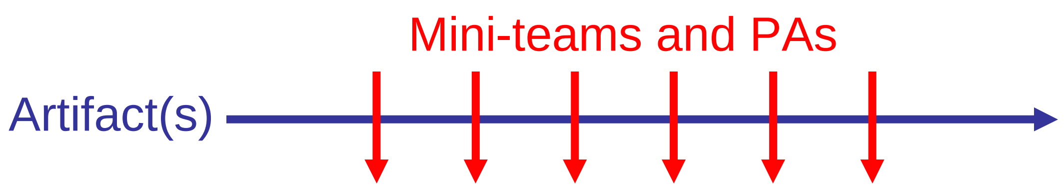
- Data does not always address practice or was difficult to understand
  - Data collector understood data, not the model
  - Data reviewer understood model, not the data

- Data is fragmented - too many pieces needed to demonstrate compliance



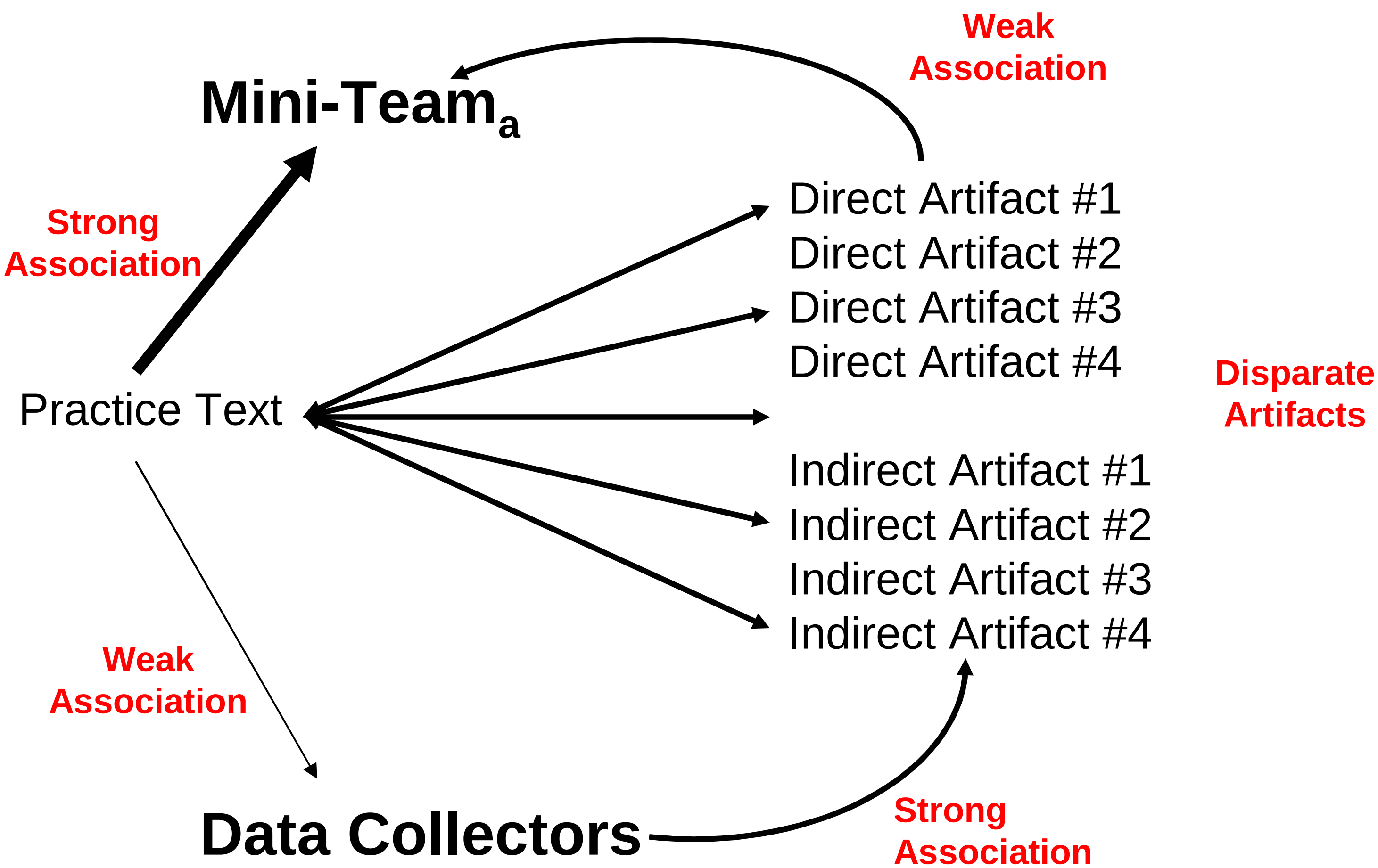
Issues - 2

- A single artifact often addressed multiple practices, all from different PAs (and mini-teams)



- Data collectors and appraisers have different views of the data

What We Had


Weak
Association
Mini-Team$_a$
Strong
Association
Direct Artifact #1
Direct Artifact #2
Direct Artifact #3
Direct Artifact #4
Practice Text
Disparate
Artifacts
Indirect Artifact #1
Indirect Artifact #2
Indirect Artifact #3
Indirect Artifact #4
Weak
Association
Data Collectors
Strong
Association

Issues - 3

- Not possible to bring appraisers up to speed on all programs
- Not practical to make data collectors model experts

SO WHAT CAN WE DO?

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An Answer -1

- We considered our options with two concepts at hand
  - What we COULD NOT do, and
  - What we COULD do

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An Answer -2

- What we could not do:
  - We could not make all of the data collectors experts in understanding and interpreting the CMMI
    - Too expensive
    - Not value added for the organization
  - We could not make program experts out of the appraisal team members
    - Not available for in depth orientation on all programs included in the appraisal
    - No value to the programs

An Answer -3

- What we could do:
  - Establish a method (process description and tools) that
    - Enables programs to adequately and accurately address a practice
    - Provide appraisal team members with a clear view of the data in the context of the program(s)
    - Allow the appraisal team to more efficiently and effectively review the data

Process Description Assumptions

- Only major artifacts would be addressed by this process
  - Program plan
  - SEMP
  - Quality Plan
  - Configuration Management Plan
  - etc.
- In general, artifacts that have Specific Practices that need to be addressed AND Generic Practices that need to be addressed
  - Ex: PPQA SPs and GP2.9
  - Ex: CM SPs and GP2.6
- Each artifact is mapped to all of the applicable PAs/Practices

Process Description

- Focus is on reviewing the data by artifact rather than by PA
  - Enabler (e.g., checklist) must be established such that it can be sorted by artifact element OR by PA/Pr
- Enabler is sorted by artifact and appropriate sections of the enabler (checklist) are provided to the selected reviewers
- Appraisers review the artifact using the checklist

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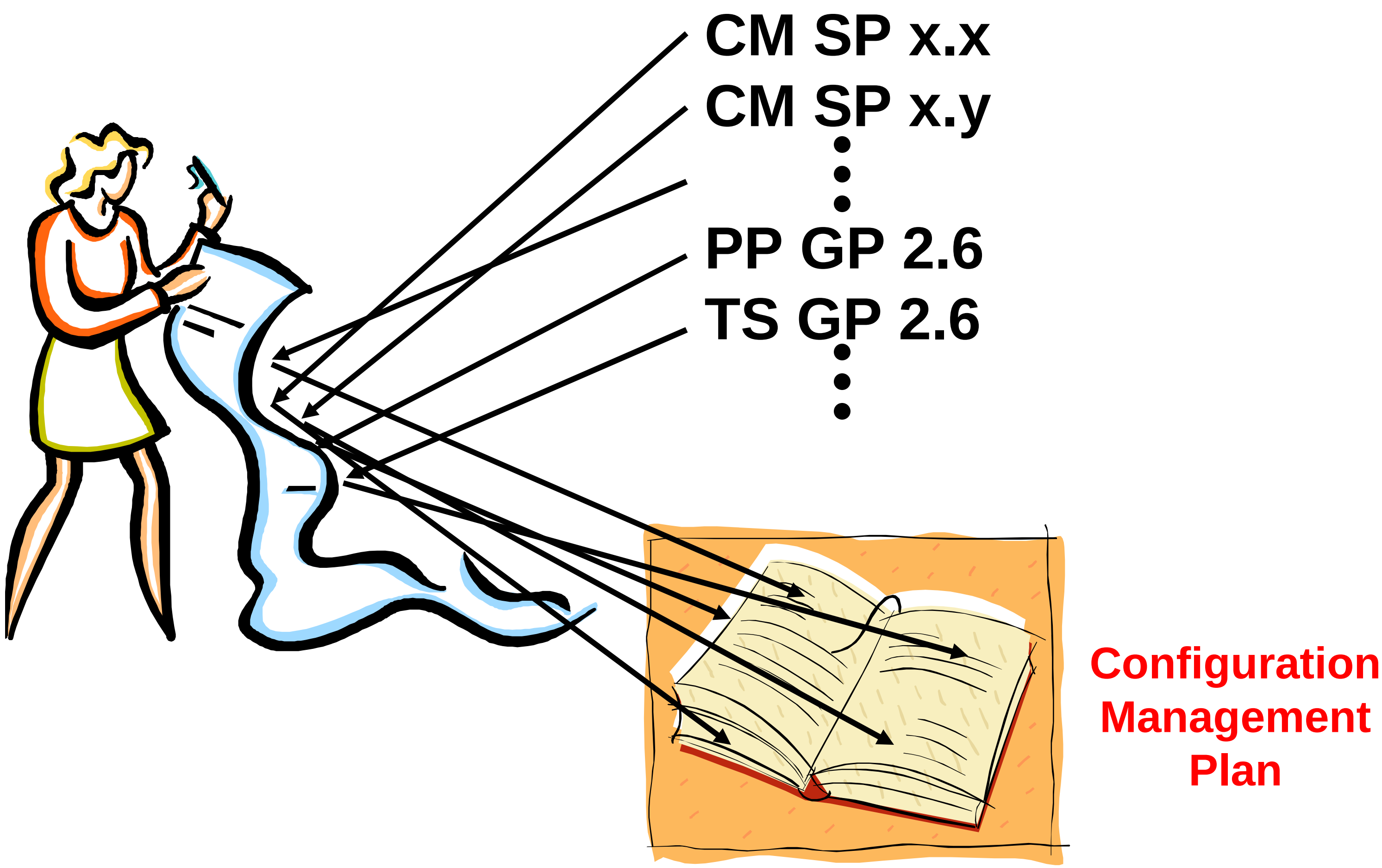
Enabler Relationship to Artifact



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The Enabler (aka “The Checklist”)

- Checklist Content
  - Artifact or plan name
  - Artifact Component
    - The plan content is derived from the organizations standard plan/artifact template
  - Maturity Level and Process Area (e.g., 2-PP)
  - Practice identifier (e.g., SP2.1)
  - Place Plan/Section Identifier
  - Place to capture the need to ask a question
  - Place for reviewer comments

Checklist For Data Review

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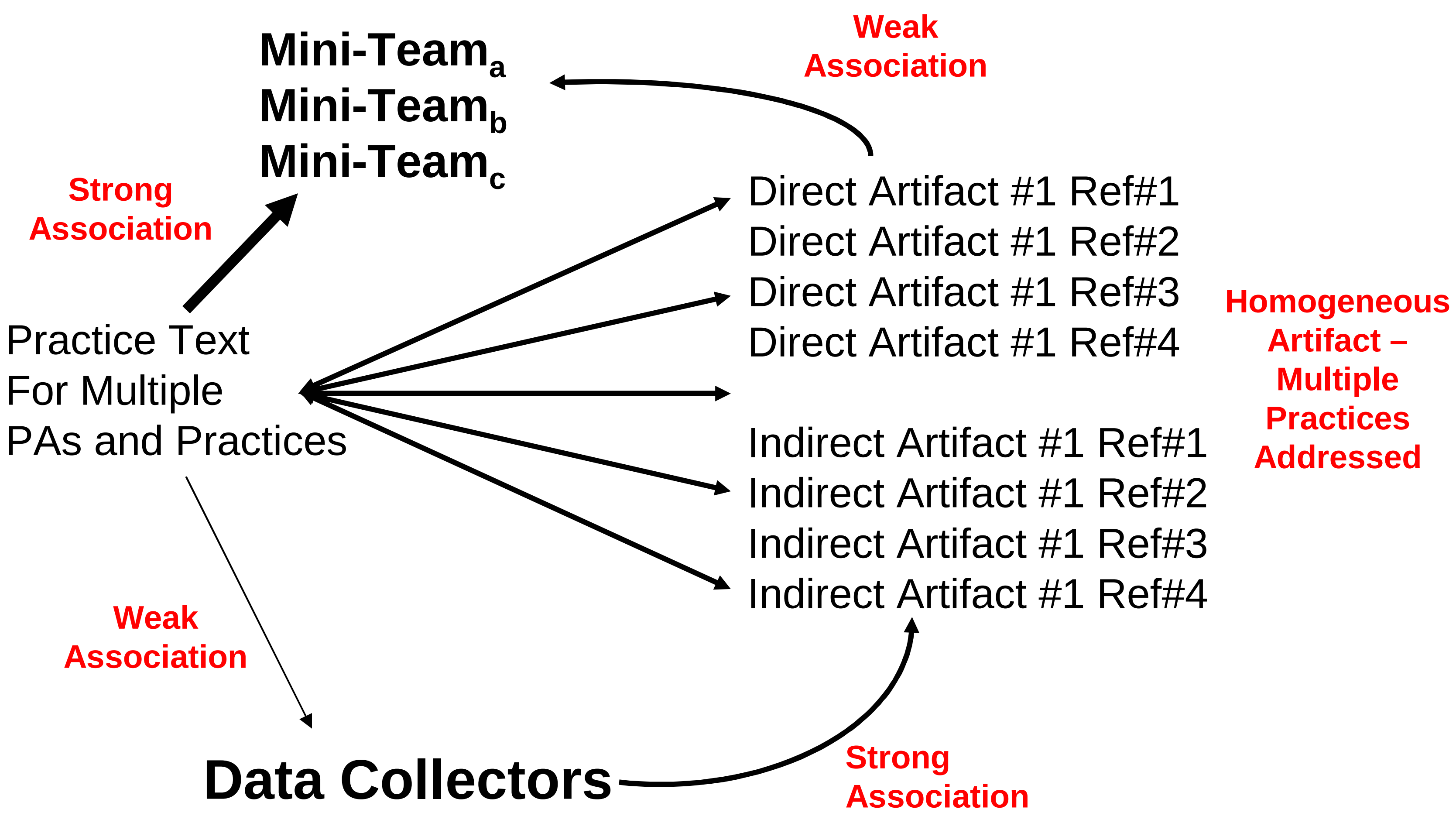
	Artifact or Plan Name	Artifact Component	Level - PA	Practice	Plan/ Section	Ask ??	Reviewer Comments
	Project Data/ Config Mgmt Plan	Configuration of Product Requirements Baseline Identified	2-REQM	GP2.6	Pgm xyz Program CM Plan, section 3.4.1	How does xyz …..?	This section identifies the right thing.
	Project Data/ Config Mgmt Plan	Configuration of Product Requirements Traceability Identified	2-REQM	GP2.6			
	Project Data/ Config Mgmt Plan	Configuration of Other Project Planning Artifacts is Identified	2-PP	GP2.6			
	Project Data/ Config Mgmt Plan	Identification of data items to be included in the project's data management plan.	2-PP	SP2.3			
	Project Data/ Config Mgmt Plan	Data management strategy	2-PP	SP2.3			
	Project Data/ Config Mgmt Plan	Data formatting standards	2-PP	SP2.3			
	Project Data/ Config Mgmt Plan	Data collection objectives	2-PP	SP2.3			

Using "The Checklist" - 1

- Review the artifact against the checklist indicating compliance as appropriate (write the location of observed evidence in the Plan/Section col.)
- Make appropriate comments if necessary
  - Handy during the discussions with the team
  - Also provides responsible team members with additional information
- Indicate if there are any questions that you would like to ask during the interview sessions
- Enter the data into the master Checklist
- Sort the checklist by PA/practice
- Provide the information to the appropriate mini-team

Where We Ended Up



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Conclusion

- Mini-teams have vetted data from all of the major plans/artifacts
- The appraisal TEAM has a better "picture" of each plan
- Mini-team members have insight into evidence beyond their own assigned areas
- Broader knowledge of "in context" information for making judgments concerning strengths, weaknesses, etc.
- References to artifacts can be checked against the checklist for acceptability, rather than having to review the same artifact multiple times

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Questions?

The ROI Dashboard©
Understanding the Benefits of CMMI

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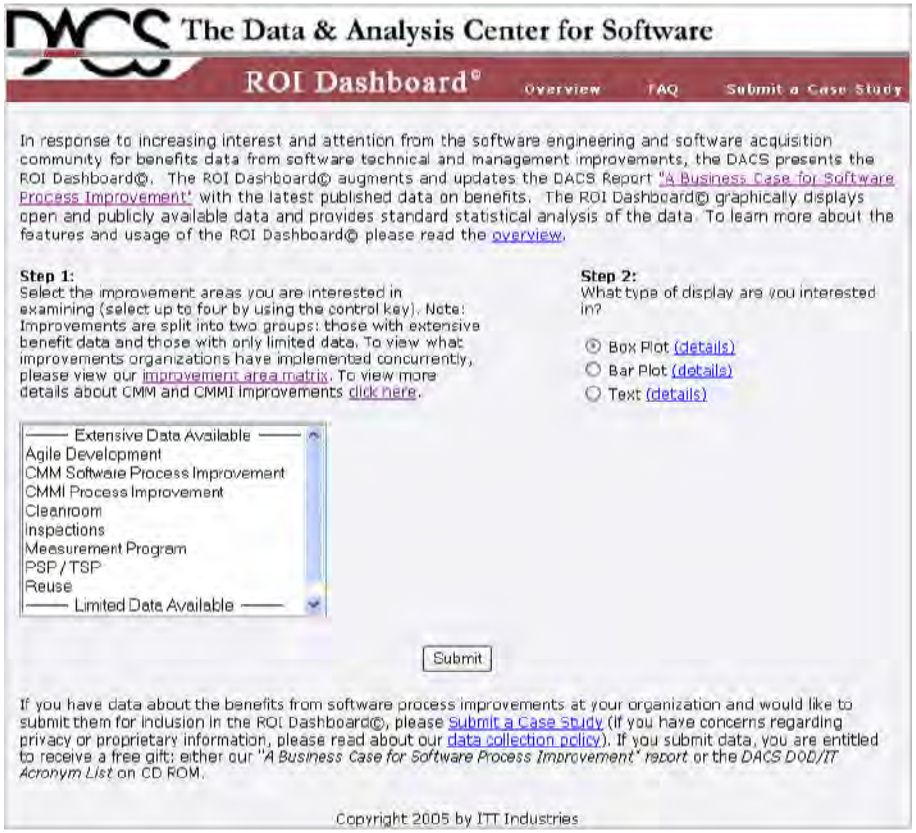
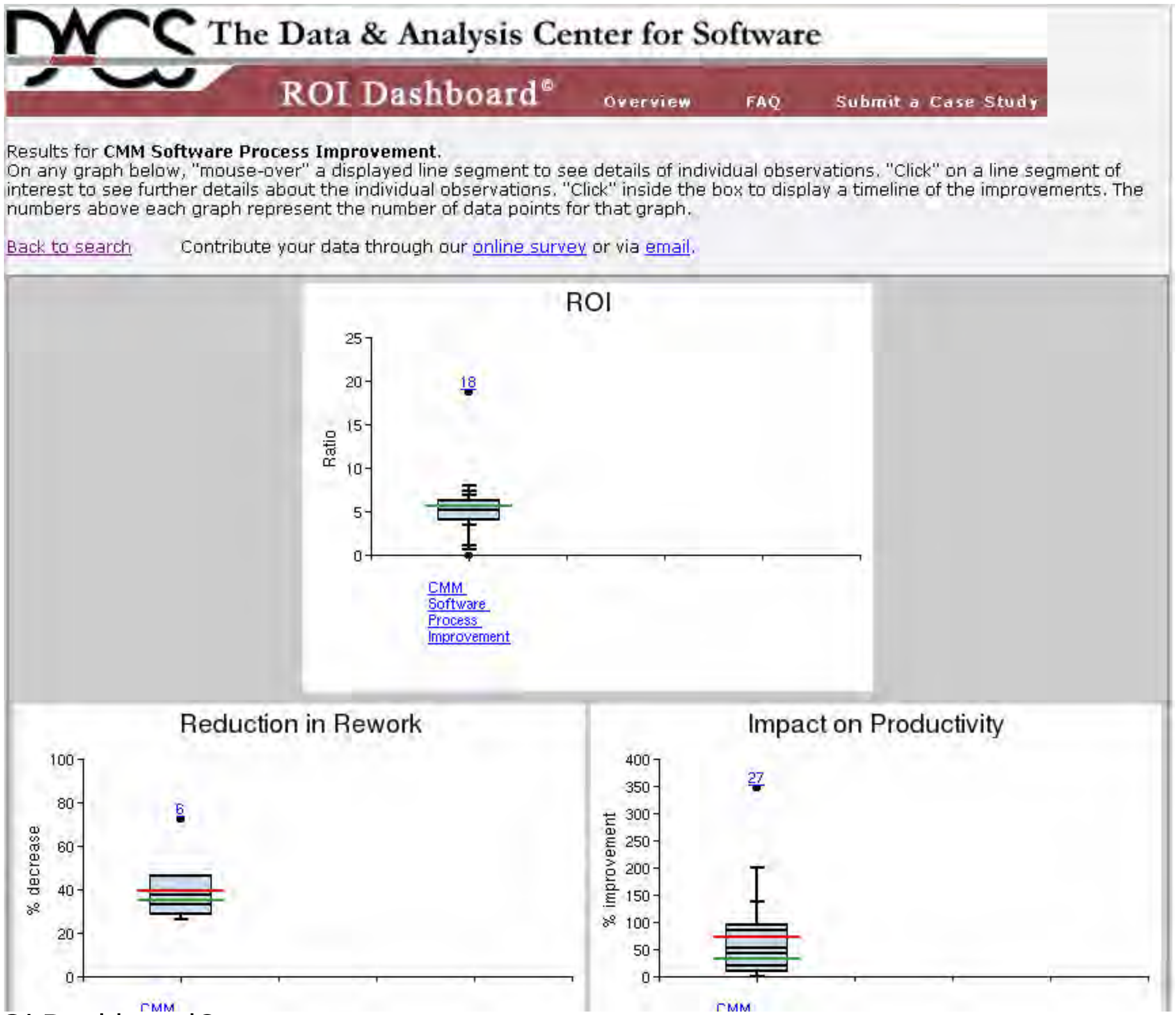
tom.mcgibbon@itt.com

ROI Dashboard©
http://www.thedacs.com/databases/roi/



- Objective: Transition from Anecdotal Evidence to Industry Trends
- Captures 10 Years of Open and Public ROI Data from Industry and Acquisition Organizations
- Organizes and Displays Data from Similar Improvements and Benefits

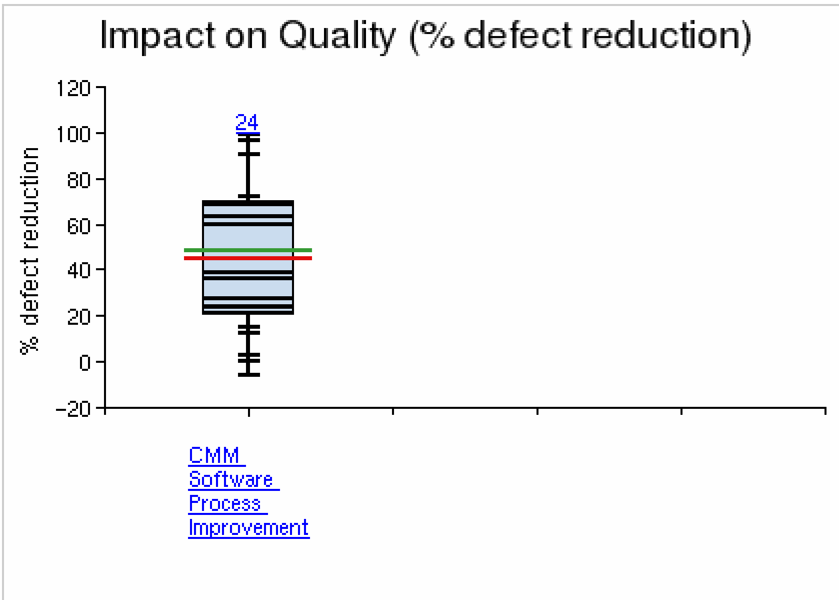
Published Data



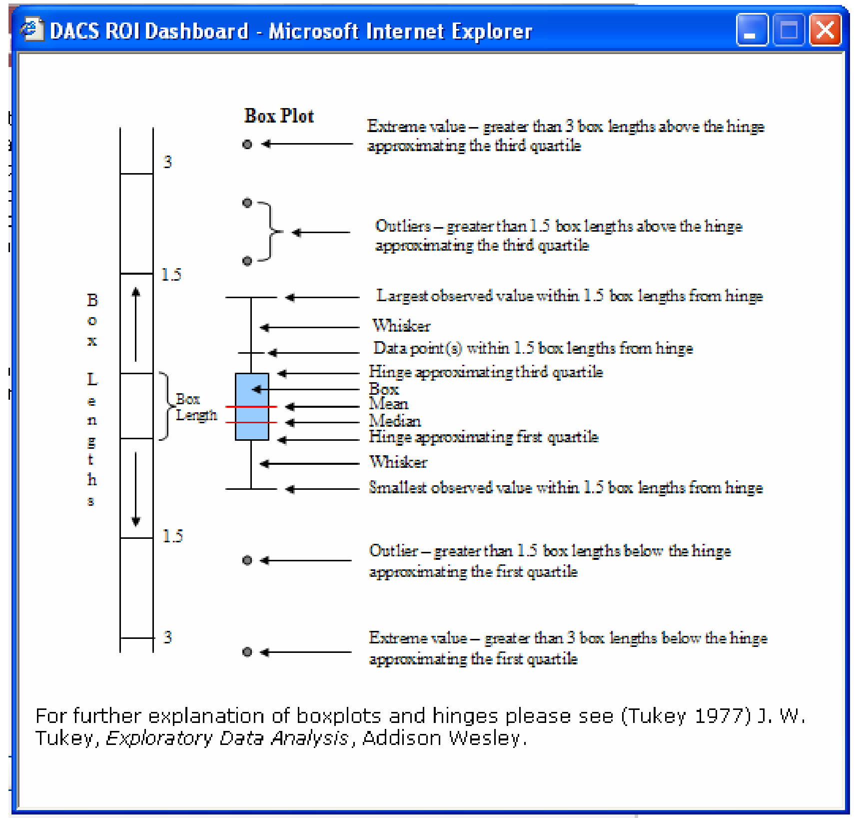
Attribute Displays:

- ROI
- Reduction in Rework
- Impact on Productivity
- Impact on Quality
  - % Defect Reduction
  - % Defects Found
- Impact on Schedule
  - Cycle Time
  - Schedule Variance
- Reduction in Project Cost
- Cost of Improvement

Box Plots

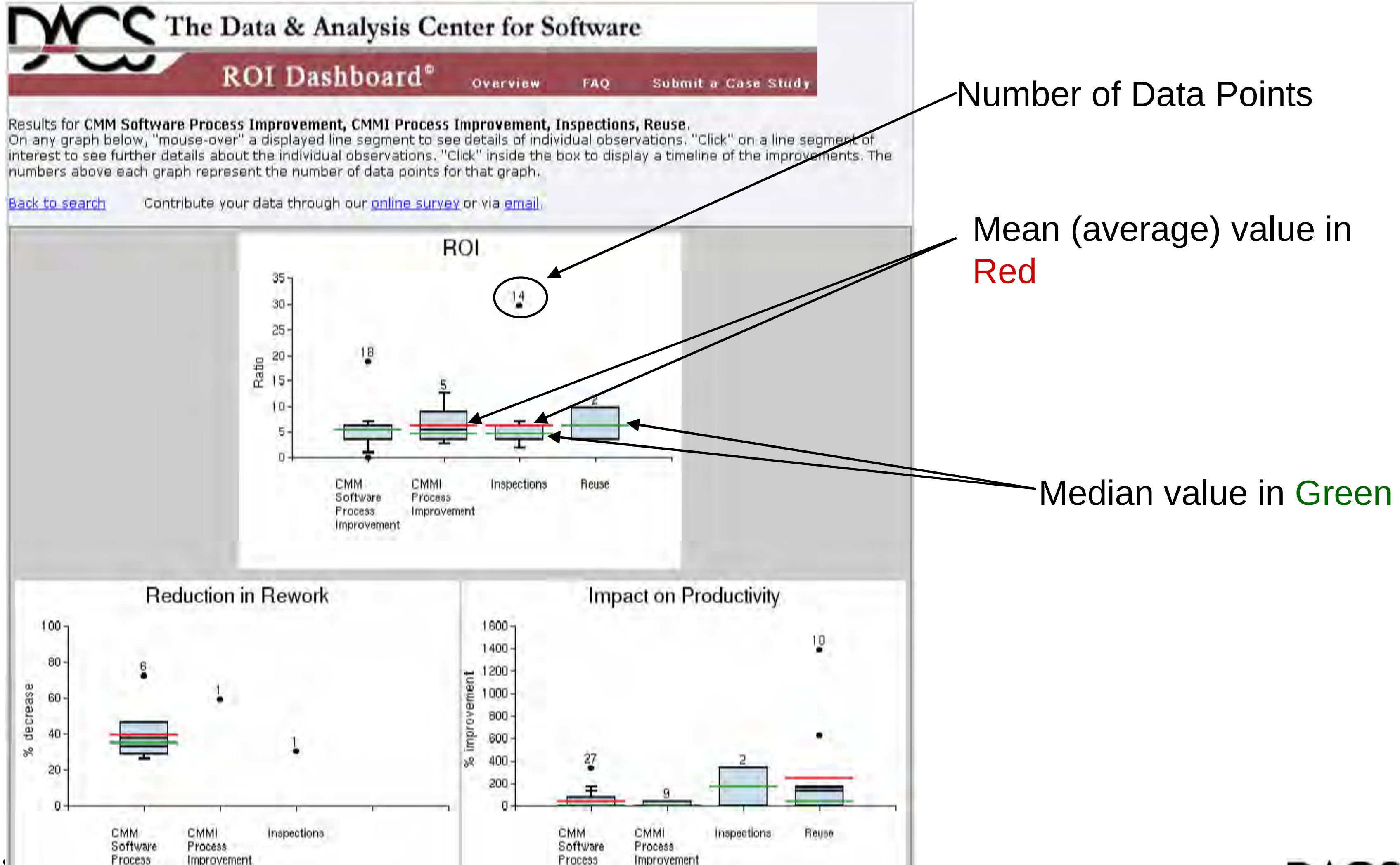


Impact on Quality (% defect reduction)
% defect reduction
120
100
80
60
40
20
0
-20
24
CMM Software Process Improvement

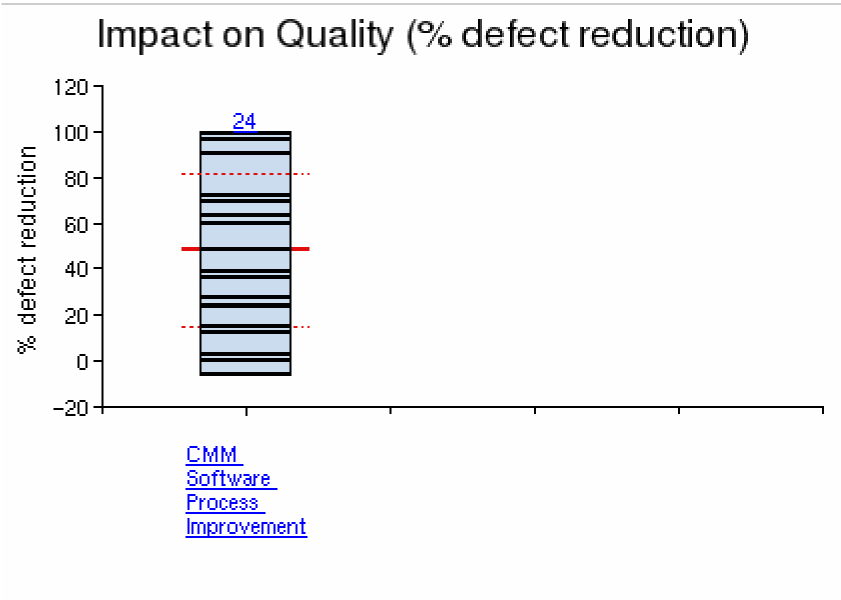


DACS ROI Dashboard - Microsoft Internet Explorer
Box Plot
Extreme value – greater than 3 box lengths above the hinge approximating the third quartile
Outliers – greater than 1.5 box lengths above the hinge approximating the third quartile
Largest observed value within 1.5 box lengths from hinge
Whisker
Data point(s) within 1.5 box lengths from hinge
Hinge approximating third quartile
Box
Mean
Median
Hinge approximating first quartile
Whisker
Smallest observed value within 1.5 box lengths from hinge
Outlier – greater than 1.5 box lengths below the hinge approximating the first quartile
Extreme value – greater than 3 box lengths below the hinge approximating the first quartile
Box Lengths
Box Length
3
1.5
1.5
3
For further explanation of boxplots and hinges please see (Tukey 1977) J. W. Tukey, *Exploratory Data Analysis*, Addison Wesley.

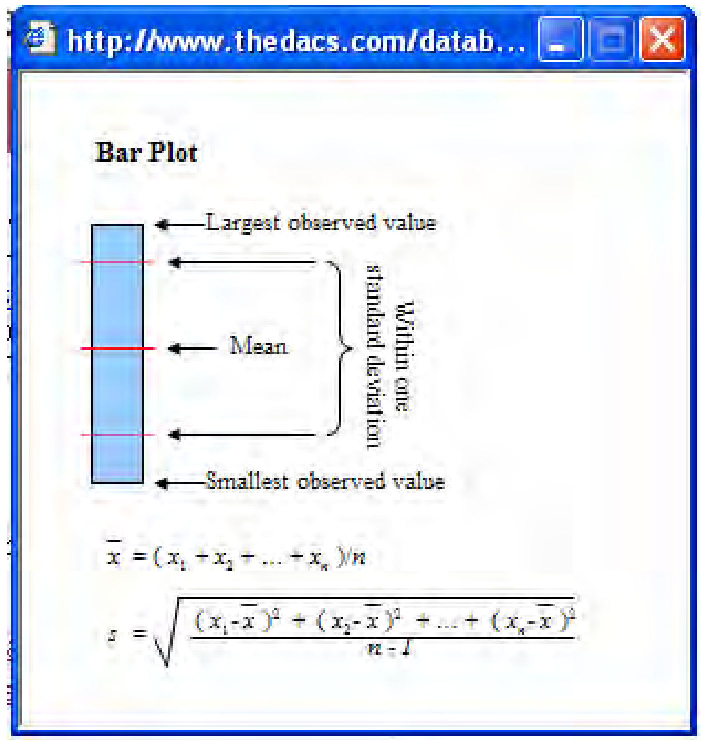
ROI Dashboard© Analyzes Benefit Data from Best Practices



Bar Plot

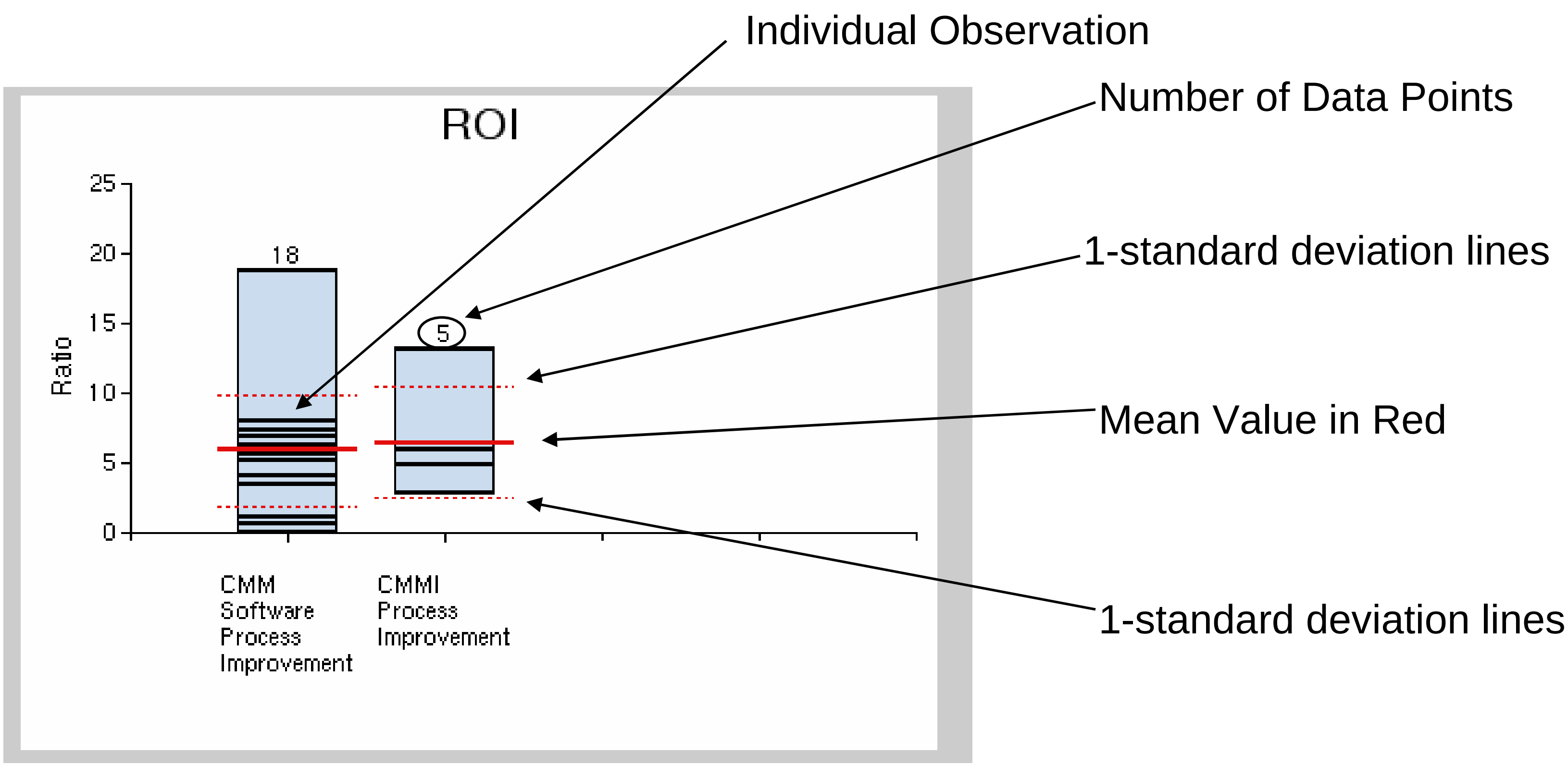


Impact on Quality (% defect reduction)
% defect reduction
120
100
80
60
40
20
0
-20
24
CMM Software Process Improvement



http://www.thedacs.com/datab...
Bar Plot
Largest observed value
Mean
Within one standard deviation
Smallest observed value
$\bar{x} = (x_1 + x_2 + \ldots + x_n)/n$
$s = \sqrt{\frac{(x_1-\bar{x})^2 + (x_2-\bar{x})^2 + \ldots + (x_n-\bar{x})^2}{n-1}}$

Sample ROI Dashboard© Bar Plot



Text

The Data & Analysis Center for Software

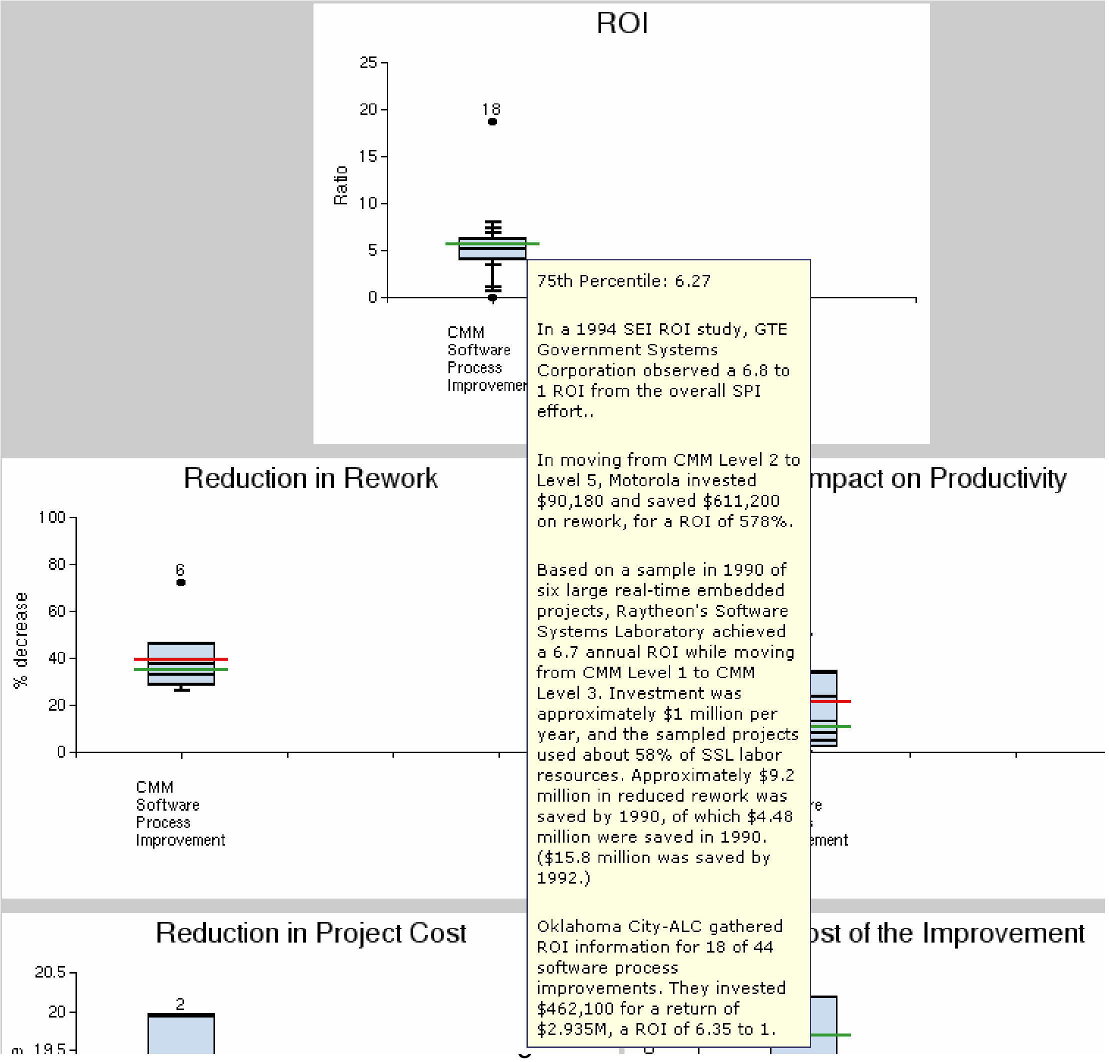
ROI Dashboard© Overview FAQ Submit a Case Study

Improvement: CMM Software Process Improvement

Metric	Total Data Points	Minimum	Maximum	Median	Mean	Standard Deviation	25th Percentile	75th Percentile
Impact on Quality (% of defects found)	3	90 % defects found	100 % defects found	94 % defects found	94.67 % defects found	5.03 % defects found	90 % defects found	100 % defects found
ROI	18	0.14 Ratio	19 Ratio	6 Ratio	5.9 Ratio	3.99 Ratio	4.3 Ratio	6.8 Ratio
Impact on Quality (% defect reduction)	24	-6 % defect reduction	100 % defect reduction	50 % defect reduction	47.9 % defect reduction	33.16 % defect reduction	22 % defect reduction	72 % defect reduction
Impact on Cycle Time	12	-19 % decrease	90 % decrease	43 % decrease	40.5 % decrease	36.09 % decrease	14.5 % decrease	70 % decrease
Impact on Schedule Variance	10	-50 % decrease	98 % decrease	46 % decrease	43.3 % decrease	40.73 % decrease	33 % decrease	67 % decrease
Impact on Productivity	27	-5 % improvement	350 % improvement	37 % improvement	81.78 % improvement	98.06 % improvement	18 % improvement	100 % improvement
Reduction in Rework	6	28 % decrease	73 % decrease	36 % decrease	41.5 % decrease	16.71 % decrease	30 % decrease	46 % decrease
Reduction in Project Cost	2	18 % decrease	20 % decrease	19 % decrease	19 % decrease	1.41 % decrease	18 % decrease	20 % decrease
Cost of the Improvement	2	2 % of total effort	3.15 % of total effort	2.58 % of total effort	2.58 % of total effort	0.81 % of total effort	2 % of total effort	3.15 % of total effort

Rate this page's content: poor ○ ○ ○ ○ ○ ○ excellent [Submit]

ROI Dashboard© Provides Visibility into Data



Details Available When Needed

The Data & Analysis Center for Software

ROI Dashboard© Overview FAQ Submit a Case Study

Fact Information

From 1992 to 1999, **Thomson - CSF** implemented the following Improvements:
- CMM Software Process Improvement

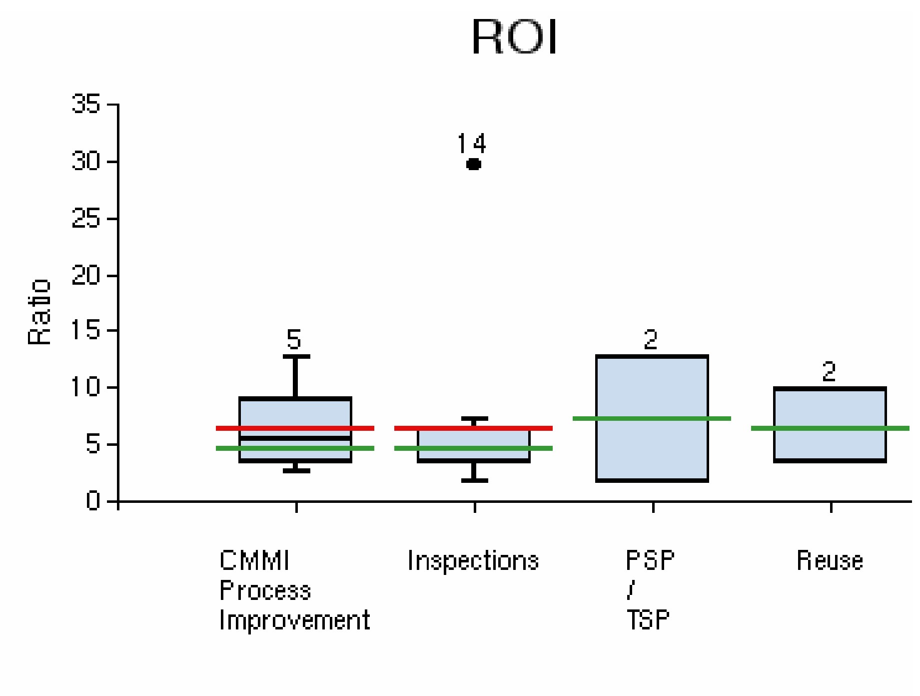
BACKGROUND:

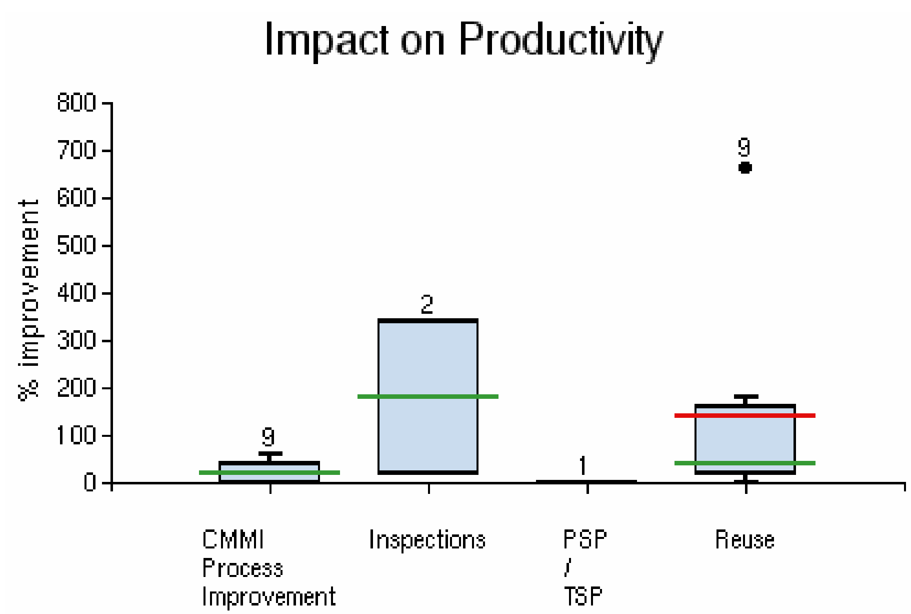
- Company currently known as Thales
- European worldwide leader, $7 billion in yearly revenues
- 50,000 employees, 50% engineers, 30% outside France

OBSERVED RESULTS:
Thomson - CSF observed the following changes:

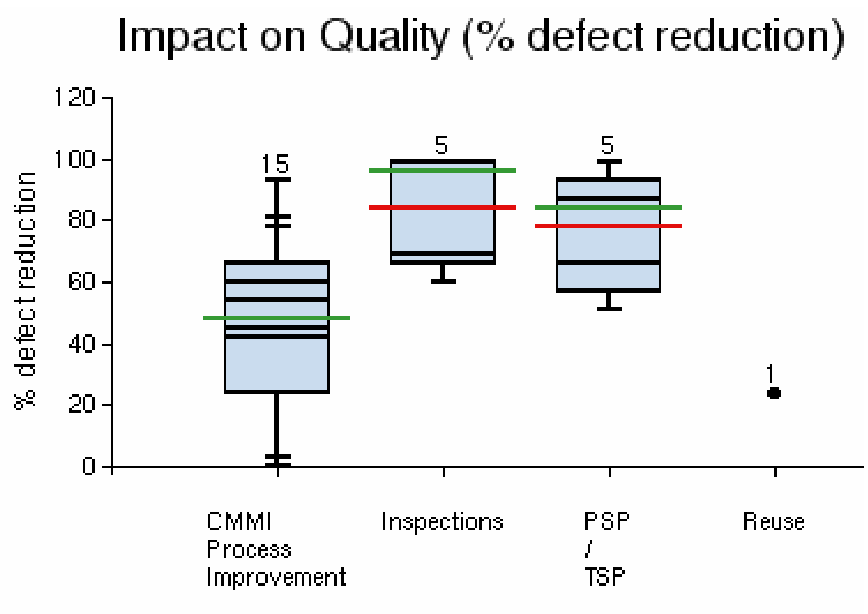
- The overall cost (investment) of the improvement was ~2.8 to ~3.5 % of Software Effort measured after the improvements(CMM Level 2 Organizations)
- The overall cost (investment) of the improvement was ~2 % of Software Effort measured after the improvements(CMM Level 3 Organizations)
- The overall cost (investment) of the improvement was 31,000 hours measured after the improvements(CMM Level 1 to CMM Level 3)
- The cost of training was 2 days / year measured after the improvements(Training required to reach CMM Level 2)
- The cost of training was 3 days / year measured after the improvements(Training required to reach CMM Level 3)
- Estimated savings in development cost was ~57,000 to ~100,000 hours measured after the improvements(CMM Level 1 to CMM Level 3, 1992-1997)
- The Return-on-Investment (Cost Savings/Cost of Improvement) was 4.3 Ratio measured after the improvements (CMM Level 2, 1993-1995)
- The Return-on-Investment (Cost Savings/Cost of Improvement) was 3.75 Ratio measured after the improvements(CMM Level 3, 1996-1997)
- The deviation in actual cost compared with estimated cost was ~130 to ~150 % measured before the improvements and 0 % measured after the improvements(CMM Level 1 to CMM Level 3)
- The number of defects delivered to the customer was ~130 to ~150 % measured before the improvements and 0 % measured after the improvements(CMM Level 1 to CMM Level 3)
- Total defects observed was ~50 % measured after the improvements(In Peer Code Reviews (80 % of code))
- The number of defects delivered to the customer was 44 measured before the improvements and 9 measured after the improvements(1993-1996, from 2 CMM Level 1 projects to 4 CMM Level 2 projects)
- The number of defects delivered to the customer was 9 measured before the improvements and 3.4 measured after the improvements(1996-1997, from 4 CMM Level 2 projects to 18 CMM Level 3 Projects)
- Increase in Schedule Performance Index, where SPI is the ratio at the scheduled completion date of the amount of work performed and all scheduled work. was 50 % measured after the improvements(CMM Level 1 to CMM Level 2)

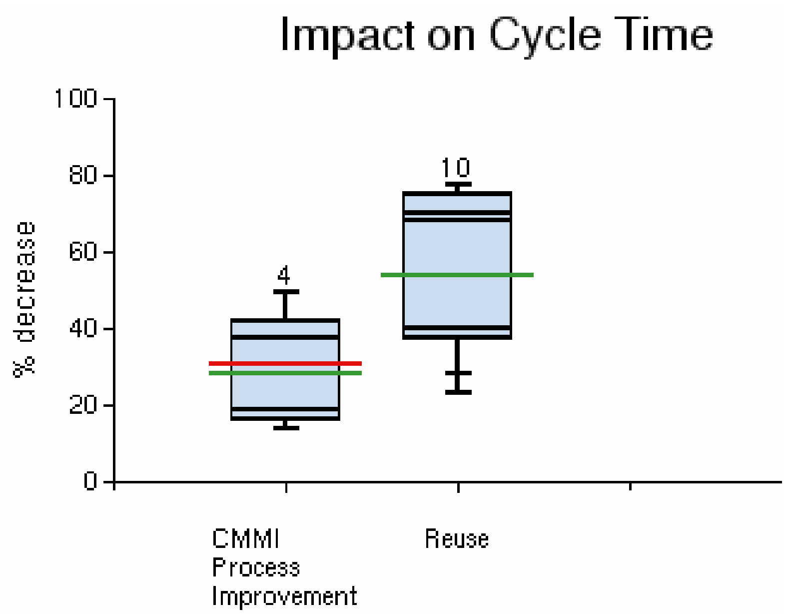
Combined - ROI Dashboard©



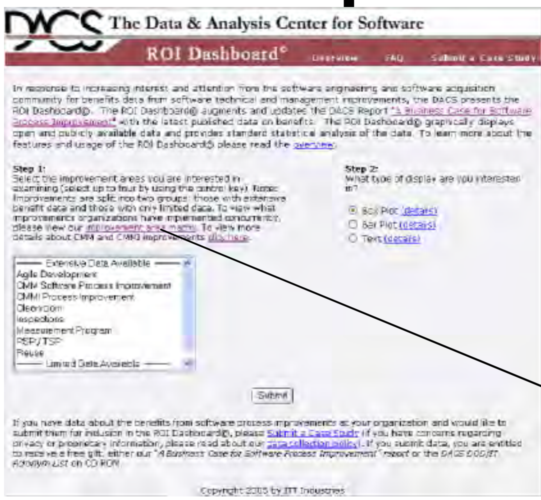


Combined - ROI Dashboard©





Improvement Area Matrix



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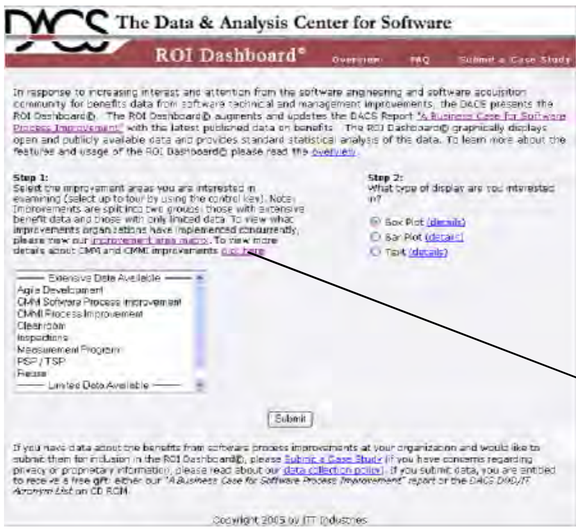
Improvement Area Matrix

The following table shows which pairs of improvements are commonly performed together by organizations currently in the DACS ROI Database. Each cell contains the total count of records found in our database (where the improvement pair is defined by the row and column). You can view the matching records by clicking on the total count.

	Agile Development	CMM Software Process Improvement	CMMI Process Improvement	Cleanroom	ISO 9001	Inspections	Measurement Program	PSP / TSP	Reuse
Agile Development	10	0	0	0	0	0	0	0	0
CMM Software Process Improvement	0	63	9	1	1	7	0	2	1
CMMI Process Improvement	0	9	23	0	0	0	0	2	0
Cleanroom	0	1	0	5	0	0	0	0	1
ISO 9001	0	1	0	0	1	0	0	0	0
Inspections	0	7	0	0	0	19	0	0	0
Measurement Program	0	0	0	0	0	0	3	0	0
PSP / TSP	0	2	2	0	0	0	0	11	0
Reuse	0	1	0	1	0	0	0	0	19

Rate this page's content: poor excellent Submit

Access Detailed CMM/CMMI Data



ROI Dashboard Data

CMMI Data

Analysis of ROI Dashboard© Data

As of 10/6/05	Agile Development	CMM SPI	CMMI PI	Cleanroom	Inspections	Meaurement Program	PSP/TSP	Reuse	ISO 9001	Total
Number of Reports	10	63	23	5	19	3	11	19	1	154
Quality: % Defect Reduction	4	24	16		5	1	5	1	1	57
Quality: % Defects Found		3	1	1	6		2			13
Quality: Reduction in Rework		6	1		1					8
Total Quality Related	*4*	*33*	*18*	*1*	*12*	*1*	*7*	*1*	*1*	78
Cost: Productivity Impacts	3	27	9	2	2		1	10		54
Cost: Reduction in Program Costs		2	2		1	1	1			7
Total Cost Related	*3*	*29*	*11*	*2*	*3*	*1*	*2*	*10*		61
Schedule: Impact on Cycle Time	2	12	4	1				10		29
Schedule: Schedule Variance Impact		10	1				2			13
Total Schedule Related	*2*	*22*	*5*	*1*			*2*	*10*		42
ROI: Return on investment		18	5	1	14	2	2	3	1	46
Cost of Improvement		2			1	1		1		5
Total Benefits Observed	9	104	39	5	30	5	13	25	2	232

CMMI Statistical Summary

The Data & Analysis Center for Software

ROI Dashboard© Overview FAQ Submit a Case Study

Improvement: CMMI Process Improvement

Metric	Total Data Points	Minimum	Maximum	Median	Mean	Standard Deviation	25th Percentile	75th Percentile
ROI	5	3 Ratio	13.3 Ratio	5 Ratio	6.46 Ratio	3.98 Ratio	4 Ratio	9.65 Ratio
Impact on Cycle Time	4	15 % decrease	50 % decrease	29 % decrease	30.75 % decrease	16.19 % decrease	17.5 % decrease	44 % decrease
Reduction in Rework	1	60 % decrease	60 % decrease	60 % decrease	60 % decrease	0 % decrease	0 % decrease	0 % decrease
Impact on Quality (% defect reduction)	16	0.5 % defect reduction	95 % defect reduction	48.5 % defect reduction	46.97 % defect reduction	29.52 % defect reduction	25.5 % defect reduction	67 % defect reduction
Impact on Productivity	9	5 % improvement	73 % improvement	30 % improvement	34.33 % improvement	25.9 % improvement	9 % improvement	59 % improvement
Impact on Schedule Variance	1	50 % decrease	50 % decrease	50 % decrease	50 % decrease	0 % decrease	0 % decrease	0 % decrease
Impact on Quality (% of defects found)	1	98 % defects found	98 % defects found	98 % defects found	98 % defects found	0 % defects found	0 % defects found	0 % defects found
Reduction in Project Cost	2	20 % decrease	40 % decrease	30 % decrease	30 % decrease	14.14 % decrease	20 % decrease	40 % decrease

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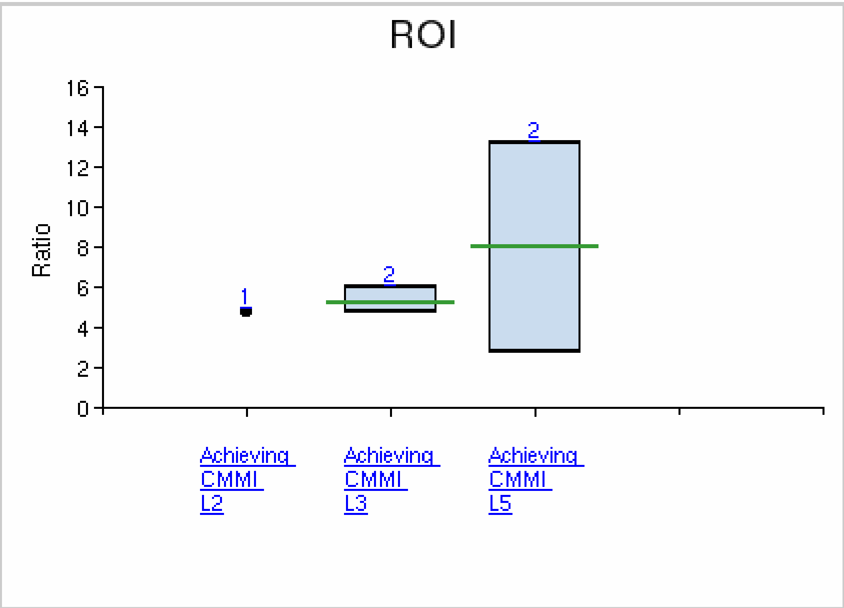
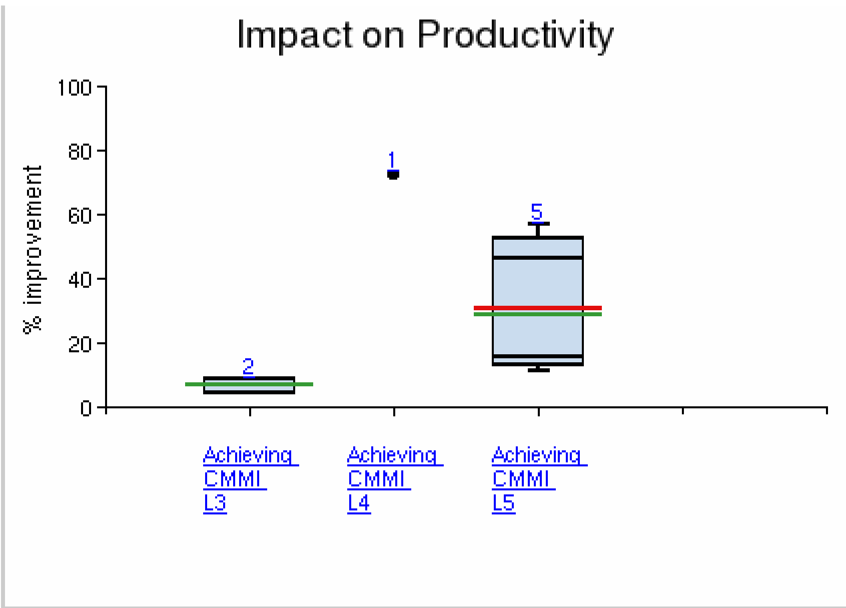
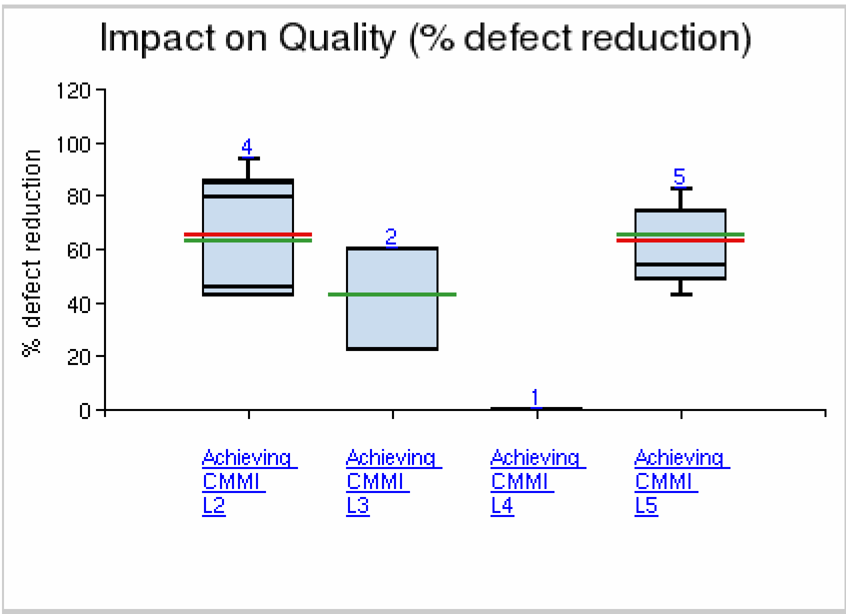
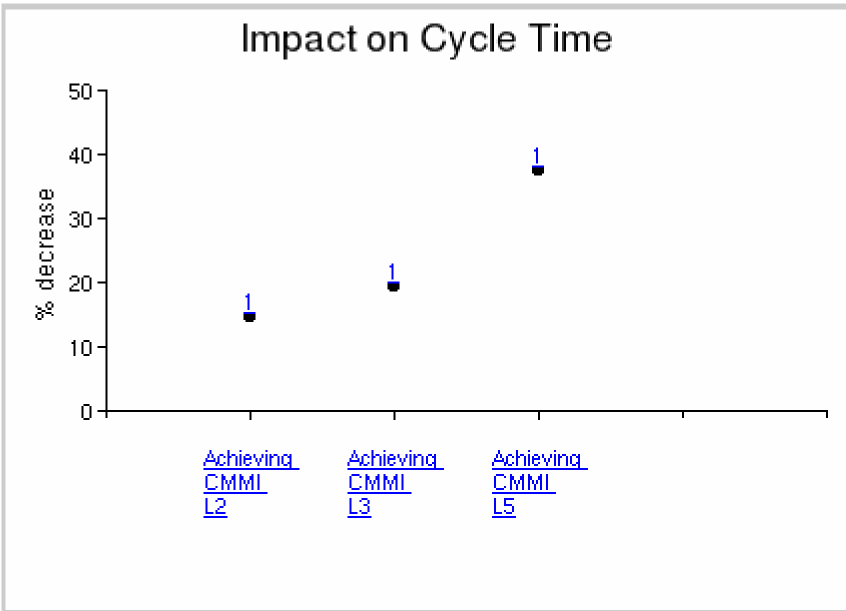
Detailed Summary Data…1



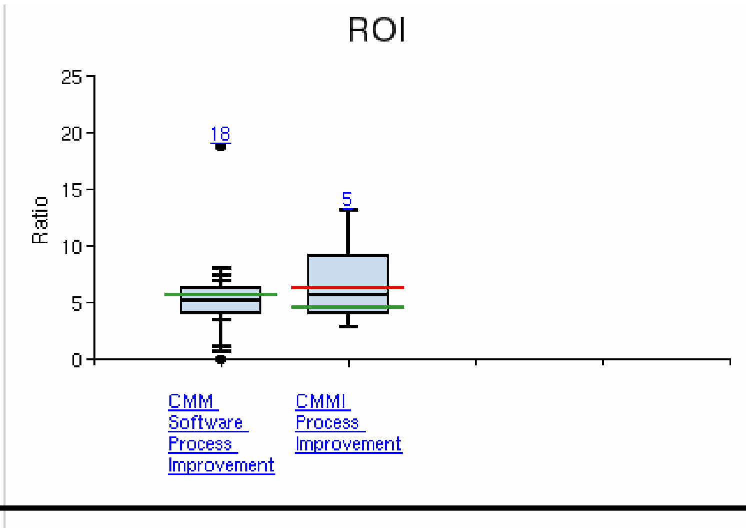


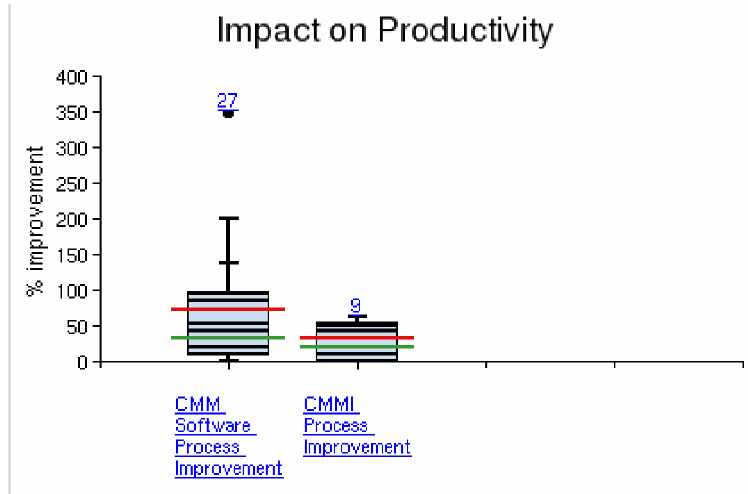
Detailed Summary Data…2

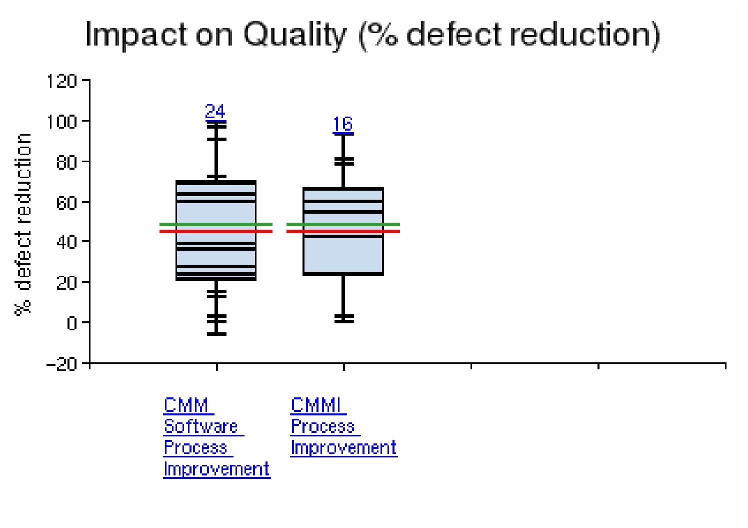


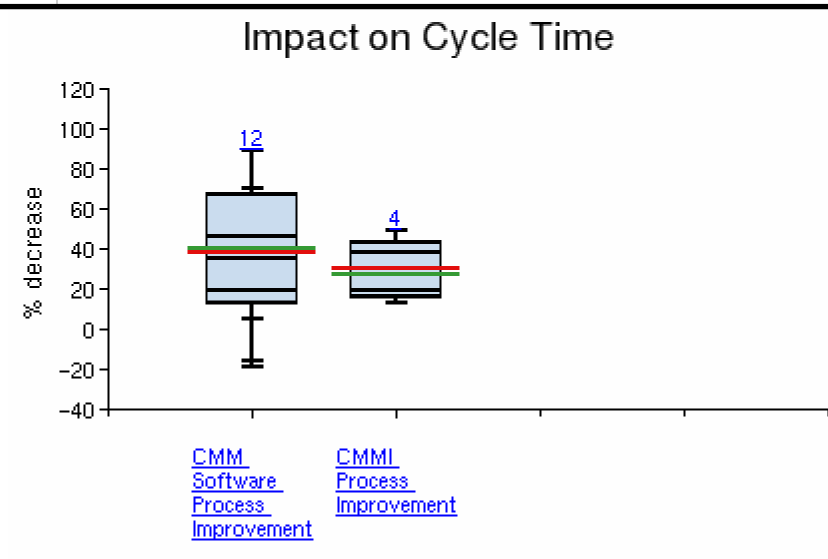


CMM vs. CMMI


ROI
Ratio
25
20
15
10
5
0
18
5
CMM Software Process Improvement
CMMI Process Improvement


Impact on Productivity
% improvement
400
350
300
250
200
150
100
50
0
27
9
CMM Software Process Improvement
CMMI Process Improvement


Impact on Quality (% defect reduction)
% defect reduction
120
100
80
60
40
20
0
-20
24
16
CMM Software Process Improvement
CMMI Process Improvement


Impact on Cycle Time
% decrease
120
100
80
60
40
20
0
-20
-40
12
4
CMM Software Process Improvement
CMMI Process Improvement

Challenges in Open Reported Data

- Data reported from commercial organizations being reported is inherently competition sensitive
- Only successes/improvements reported. Few failures.
- Some observations are vague
- Some authors only report notional data
- Data not adequately defined/quantitative. e.g. “Near Zero Defects Delivered.”
- Benefits reported, but not cost of the improvement
- Some only report averages. How to combine with specific case studies?
- Variability in units and definitions
- Inconsistent use of terms in reporting. What part of the lifecycle was measured?

Building the Business Case

- CMMI has demonstrated with quantifiable evidence of improvements in cost, schedule, and quality
- Use data in process modeling
- Compare your data to Dashboard data
  - Does it agree? If not, why not?
- Build simple spreadsheets for what if analysis

Next Steps

- Need More Data: CMMI and other
- Need Feedback from You on the ROI Dashboard© for Problems & Enhancements
- Coordination with SEI on CMMI Data

Thank You!

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Rapidly Achieving Measurable ROI Using Early Defect Detection

NDIA 2005 CMMI Technology Conference
November 16, 2005

Timothy G. Olson, President
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Presentation Objectives

"Raise the standard": describe best-in-class early defect detection and measurable results.

Provide motivation for performing early defect detection.

Describe early defect detection principles, and describe a best-in-class early defect detection process.

Describe how to estimate and measure ROI using defect dollarization.

Answer any questions.

Agenda

Why use Early Defect Detection?

World-Class Early Defect Detection

What are In-Process Inspections?

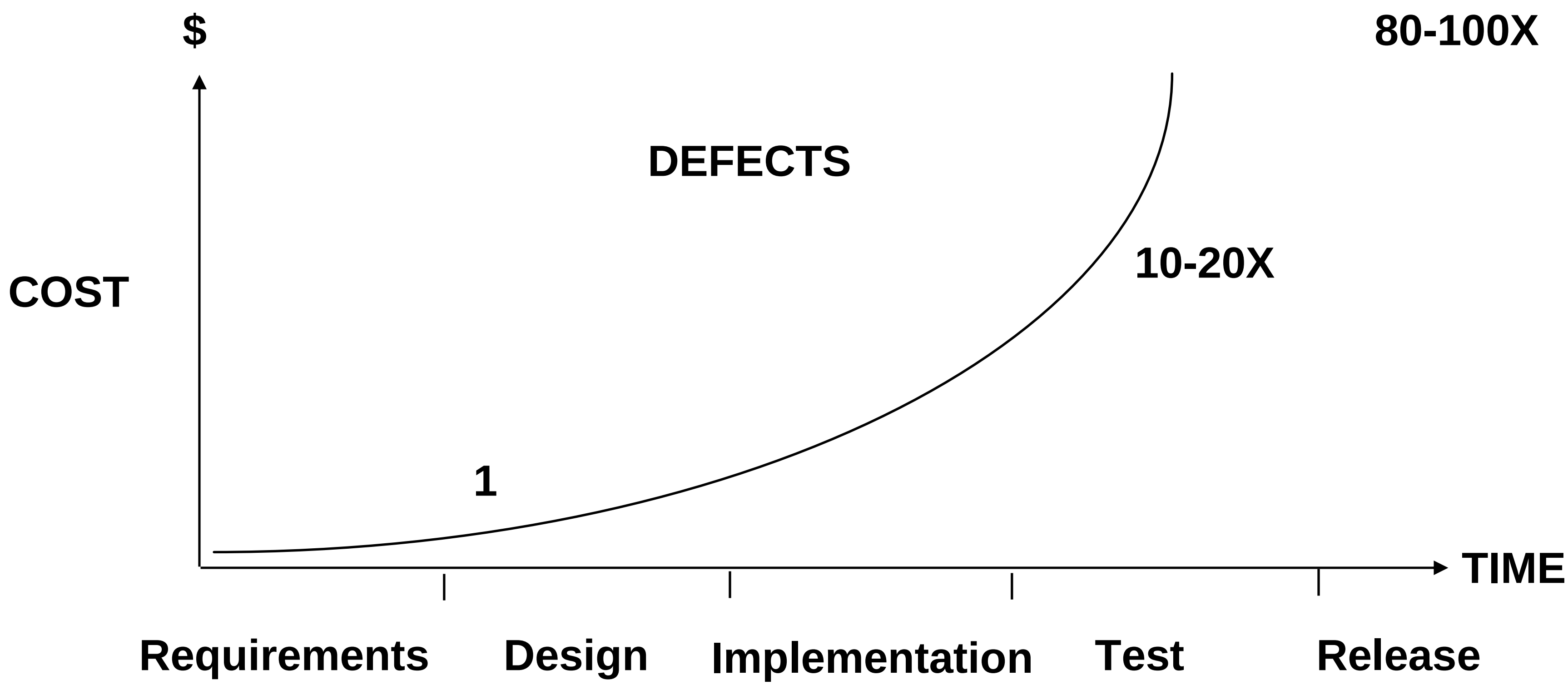
Defect Dollarization and ROI

Summary

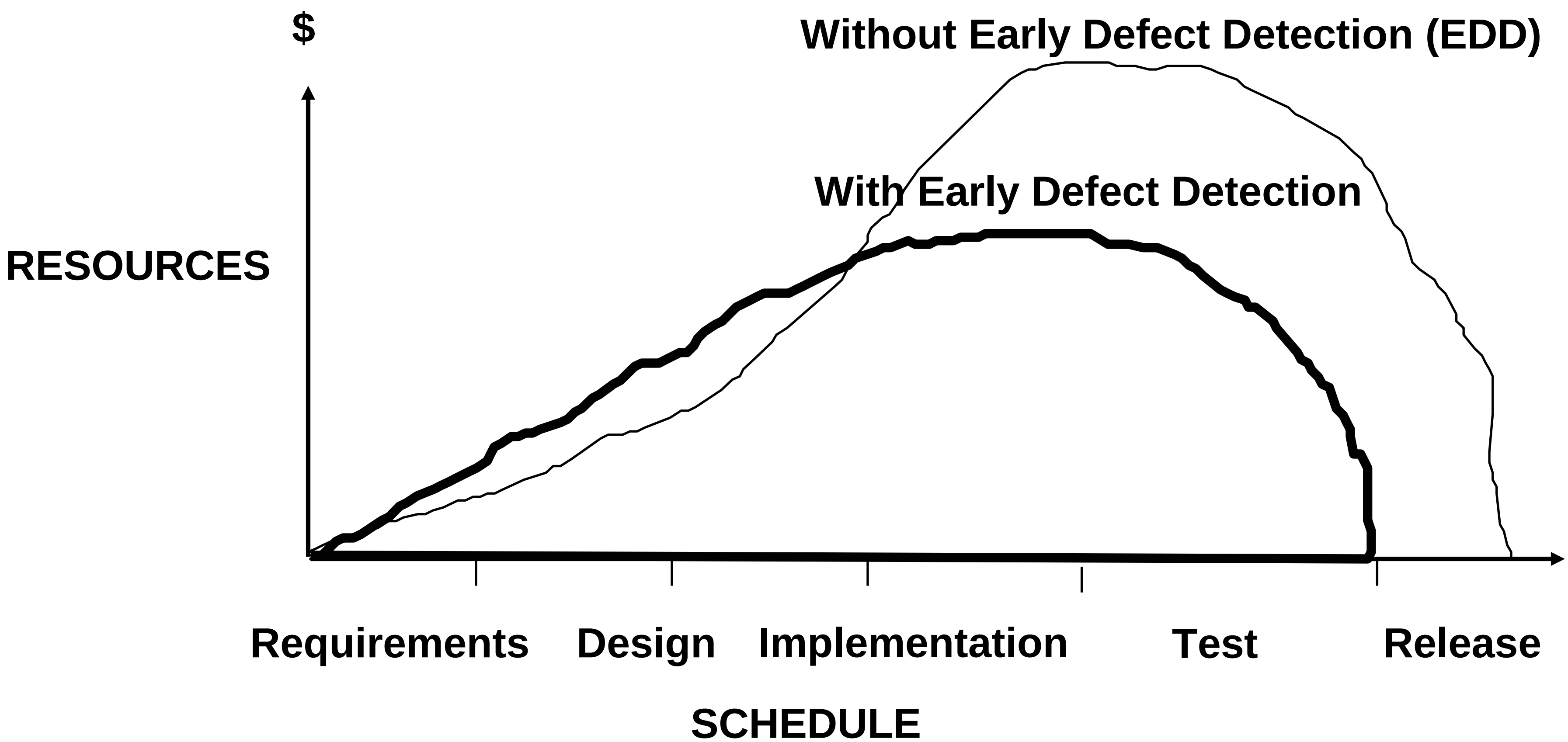
Questions and Answers

Industry Standard
Cost Ratio to Fix a Defect

Defects cost less to fix when detected earlier in the process



EDD Shortens the Schedule



- Adapted from Fagan, M. “Advances in Software Inspections”, IEEE Transactions on Software Engineering, July 1986

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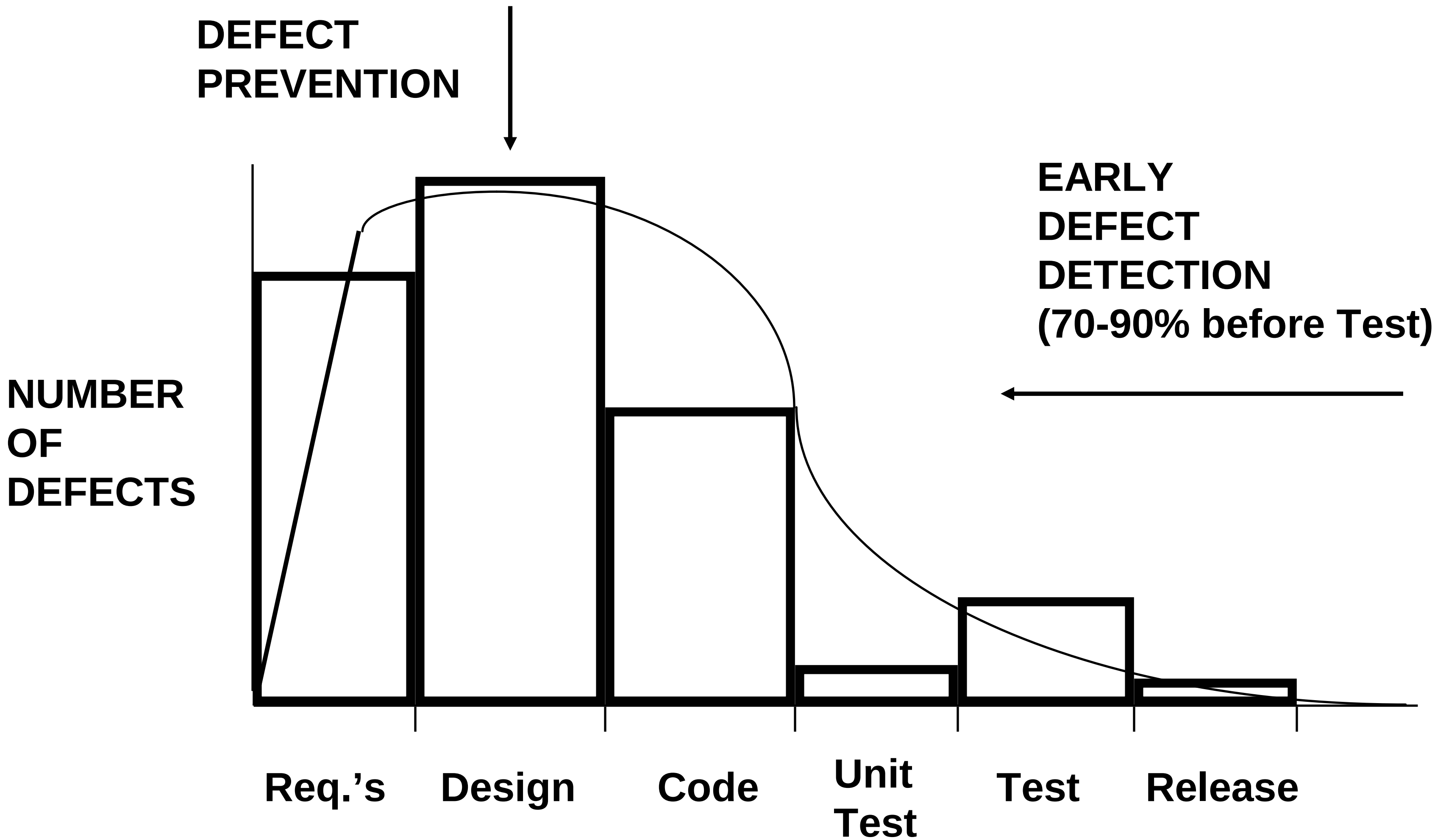
World-Class Strategies



- Slide adapted from Olson, "A Software Quality Strategy for Demonstrating Early ROI", SSQ Journal, May 1995.

Best-In-Class EDD Benchmarks

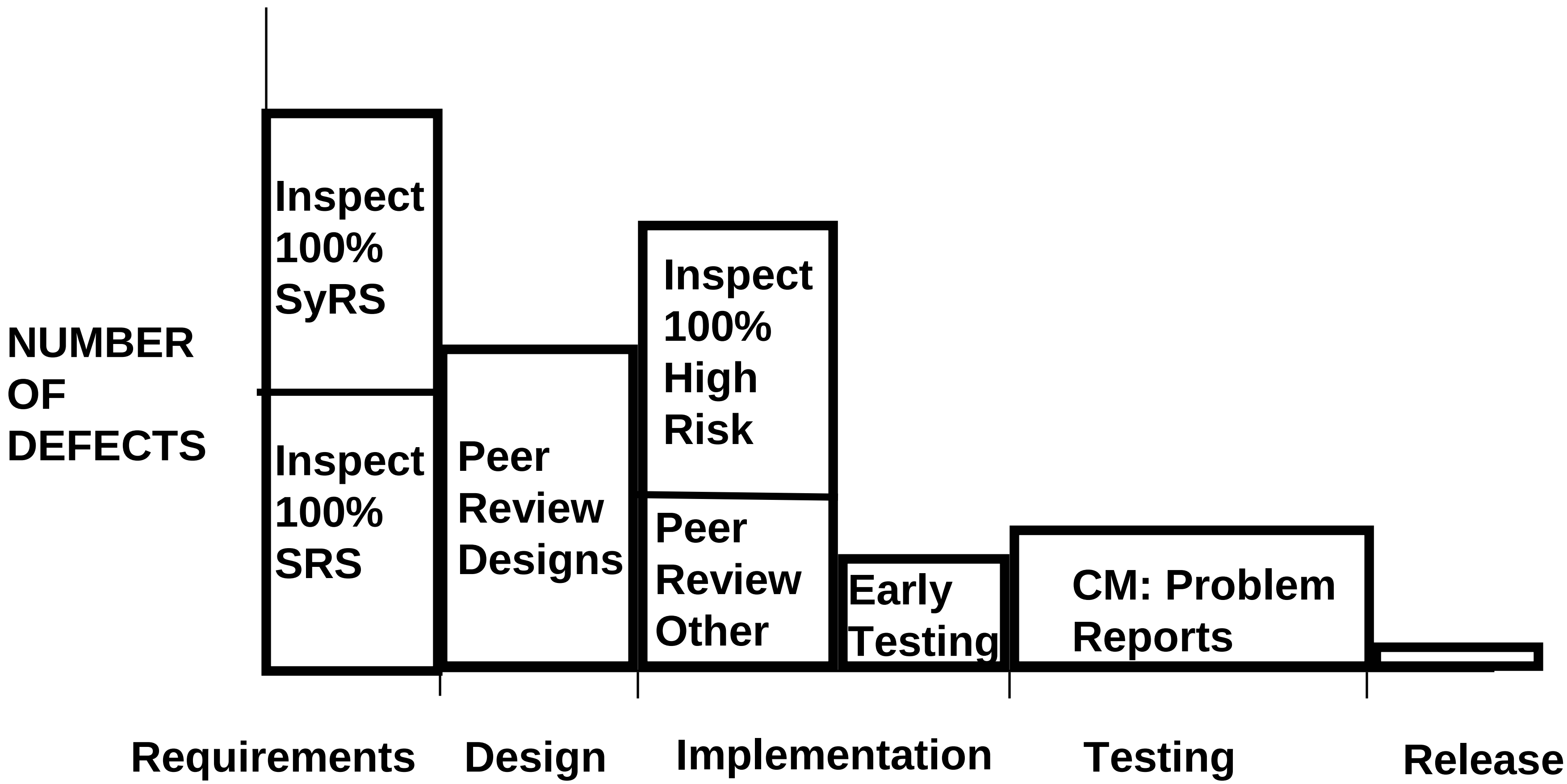
MEASUREMENT	WORLD-CLASS BENCHMARK
Costs of Poor Quality (COPQ)	Reduced from 33% to under 10% (Goal: Cut COPQ in half in 5 years)
Defect Removal Efficiency	70-90% defect removal before test
Post-Release Defect Rate	Six Sigma (3.4 defects per million) Software Benchmark: 0.01 Defects per KSLOC)
Productivity	Doubled (e.g., in 5 years at ~20% a year)
Return on Investment	5:1 - 15:1 ROI
Schedule / Cycle Time	Reduced by 10-25% (e.g., per year)

EEVVA Model

EEVVA	Review Purpose/Type
Education	Communication; Raise Issues (e.g., Walkthroughs)
Evaluation	Raise issues; Consensus (e.g., Peer Reviews)
Verification	Verify req.s; Remove defects (e.g., Inspections)
Validation	Meet user needs (e.g., User Groups)
Assurance	Product and process assurance (e.g., Audits)

•Adapted from Ebenau, *Software Inspection Process*, McGraw Hill, 1994

Example EDD Strategy: Defect Removal Efficiency (DRE)



- Slide adapted from Olson, "A Software Quality Strategy for Demonstrating Early ROI", SSQ Journal, May 1995.

EDD Strategies

Use the EEVVA Model to ensure that all reviews have a clear objective.

Use multiple EDD processes to achieve early defect detection and track defects to closure (e.g., CM, Peer Reviews, Inspections, Walkthroughs, Audits, Early Testing, etc.)

Requirements are critical documents. Formally inspect all requirement documents to remove as many defects as possible.

Formally inspect all high risk designs and code to remove as many defects as possible.

Other documents (e.g., design, code) may be peer reviewed and/or sampled.

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What are In-Process Inspections?

The purpose of in-process inspections is to detect defects early in the process in order to reduce rework and costs, and to increase quality and productivity.

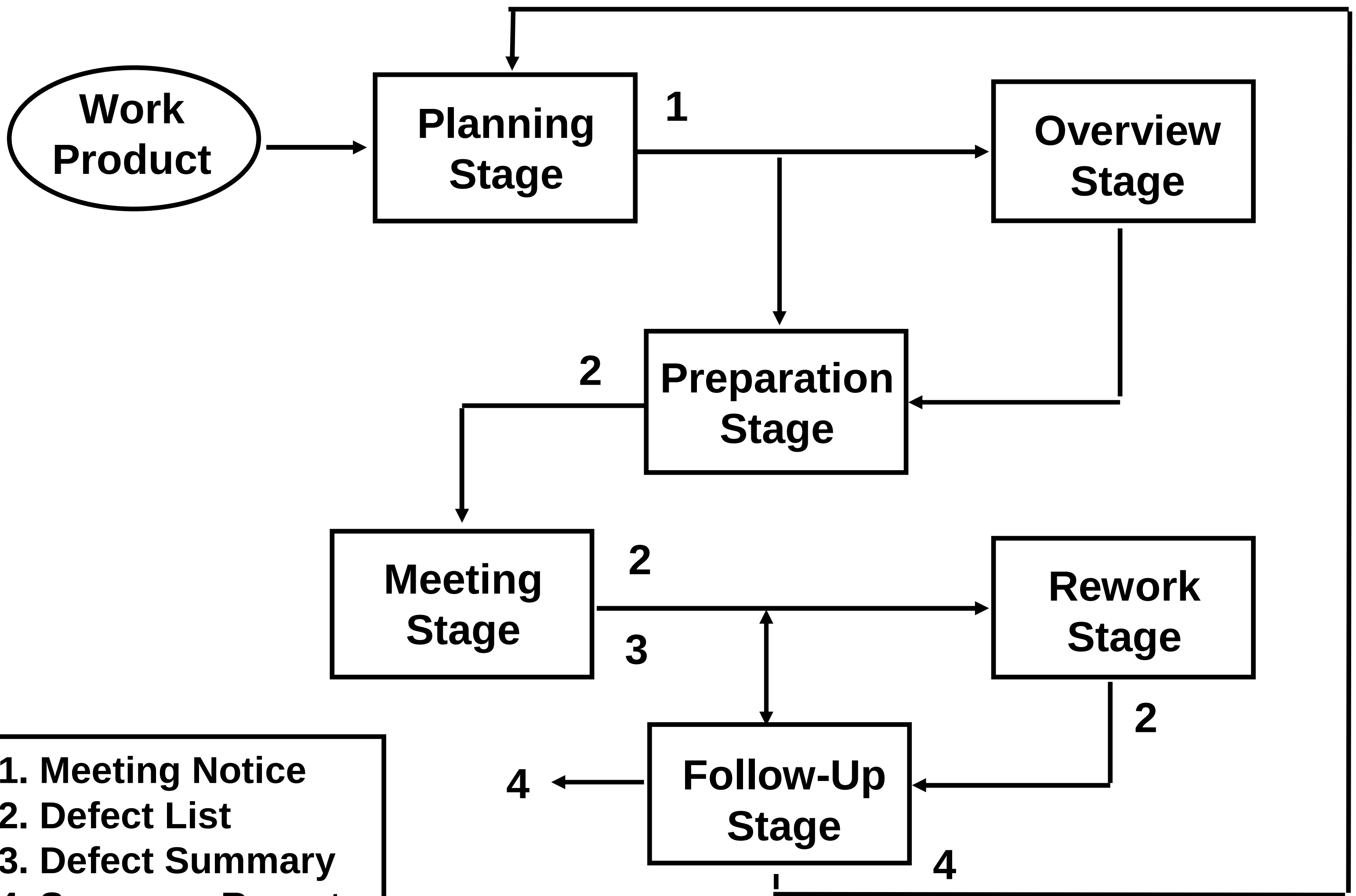
<u>In-Process Inspection:</u>
A formal process for verifying intellectual products (in-process) by manually examining a work product, a piece at a time, by small teams of trained peers to detect defects, to ensure that the product is correct and conforms to standards, product specifications, and requirements.

•**Adapted from Ebenau, *Software Inspection Process*, McGraw Hill, 1994**

What's the Difference?

Characteristics	Inspections	Reviews	Walk-throughs
Goal	Identify defects	Reach consensus Raise issues	Reach consensus Raise issues
State of Work Product	Final draft	Work in progress	Work in progress
Process/ Measurements	Formal/ Required	Informal/ None required	Informal/ None required
Checklists/ Error Detection	Required/ Defects classified	Not required/ Not required	Not required/ Not required
Participants	Moderator;Reader; Recorder; Author; Inspectors	Author; Reviewers	Author; Reviewers
Process Owner	Moderator; Independent verification	Author	Author

Inspection Process Model



1. Meeting Notice
2. Defect List
3. Defect Summary
4. Summary Report

•Adapted from Ebenau, *Software Inspection Process*, McGraw Hill, 1994

World-Class Characteristics

Some world-class EDD characteristics are:

- Well-Defined process (e.g., roles)
- Process models (e.g., Role/Flow, ETVX, SADT)
- Well-Defined measurements
  - Internal metrics (e.g., preparation rate)
  - External metrics (e.g., productivity)
- Data driven checklists
- Tailored to the organization and to the projects
- Data analysis, statistics, and reliability
- Interfaces to other processes (some examples):
  - Configuration Management
  - Defect Prevention

• Reference: World-Class Inspection Process Guide, Olson, Timothy G., 1994

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EDD ROI Assumptions

According to industry data, in-process inspections average about 7:1 ROI.

Historically, industry tests in quality (e.g., 80% of all defects are found in test).

According to industry data, defects cost 10-20 times more when found in test.

Once a defect is identified, testing processes can take 5-20 hours to fix and verify per defect.

Once a defect is identified, in-process inspections take about 0.5-1 hours to fix and verify per defect.

ROI Goal/Questions/Metrics

Goal: Measure ROI (both estimated and actual)

Key Questions:

1. How much does a defect cost in each phase of the process (e.g., design vs. test vs. release)?

2. What is the defect removal rate of the verification processes for each phase (e.g., inspections, peer reviews, testing)?

3. For each project:

- how many total defects (estimated and actual)?
- how many total defects in each phase of the process (estimated and actual)?

Key ROI Metrics

<u>Key ROI metrics to compare verification processes:</u>

- **Total percentage of project (effort or cost)**
- **Work product size by phase (e.g., total pages, KSLOC, etc.)**
- **Number of defects (total and by phase)**
- **Defect density (e.g., defects per page or KSLOC)**
- **Effort (person hours) per page or KSLOC**
- **Effort per defect (fully loaded processes)**
- **Effort per defect (after defect is identified)**
- **Defect removal efficiency (DRE)**
- **ROI = Cost Reduction/Investment (annually)**

Simple ROI Example

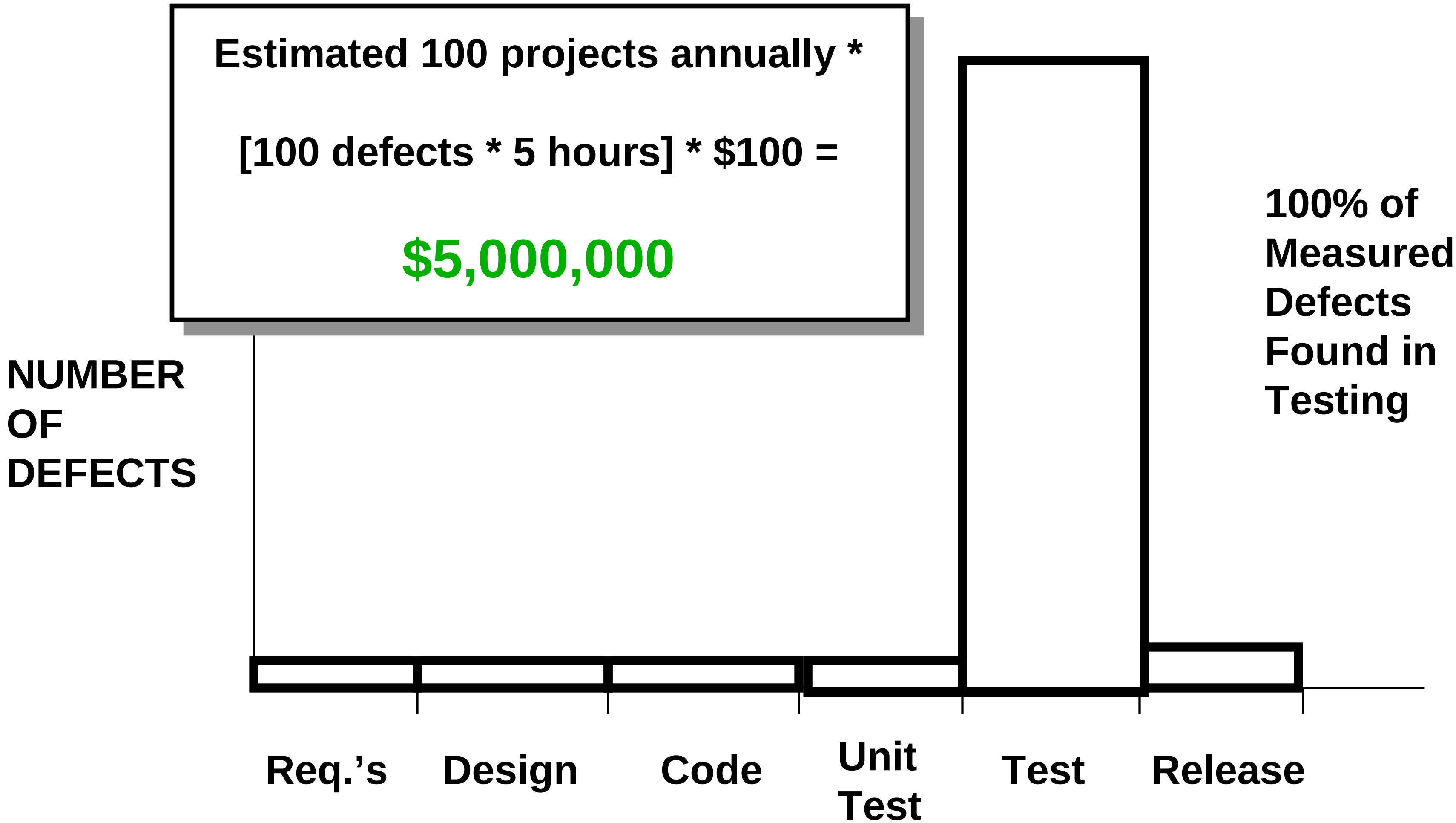
Calculate ROI using defect dollarization for 100 similar small projects (100 projects per year).

Defect ratio is 10X (0.5 hours to fix defect early in the process and 5 hours to fix a defect in test). NOTE: 10X is usually the best case. Many times it is 15X or 20X.

Our simple example will assume no previous EDD, and 75% defect removal efficiency after installing EDD.

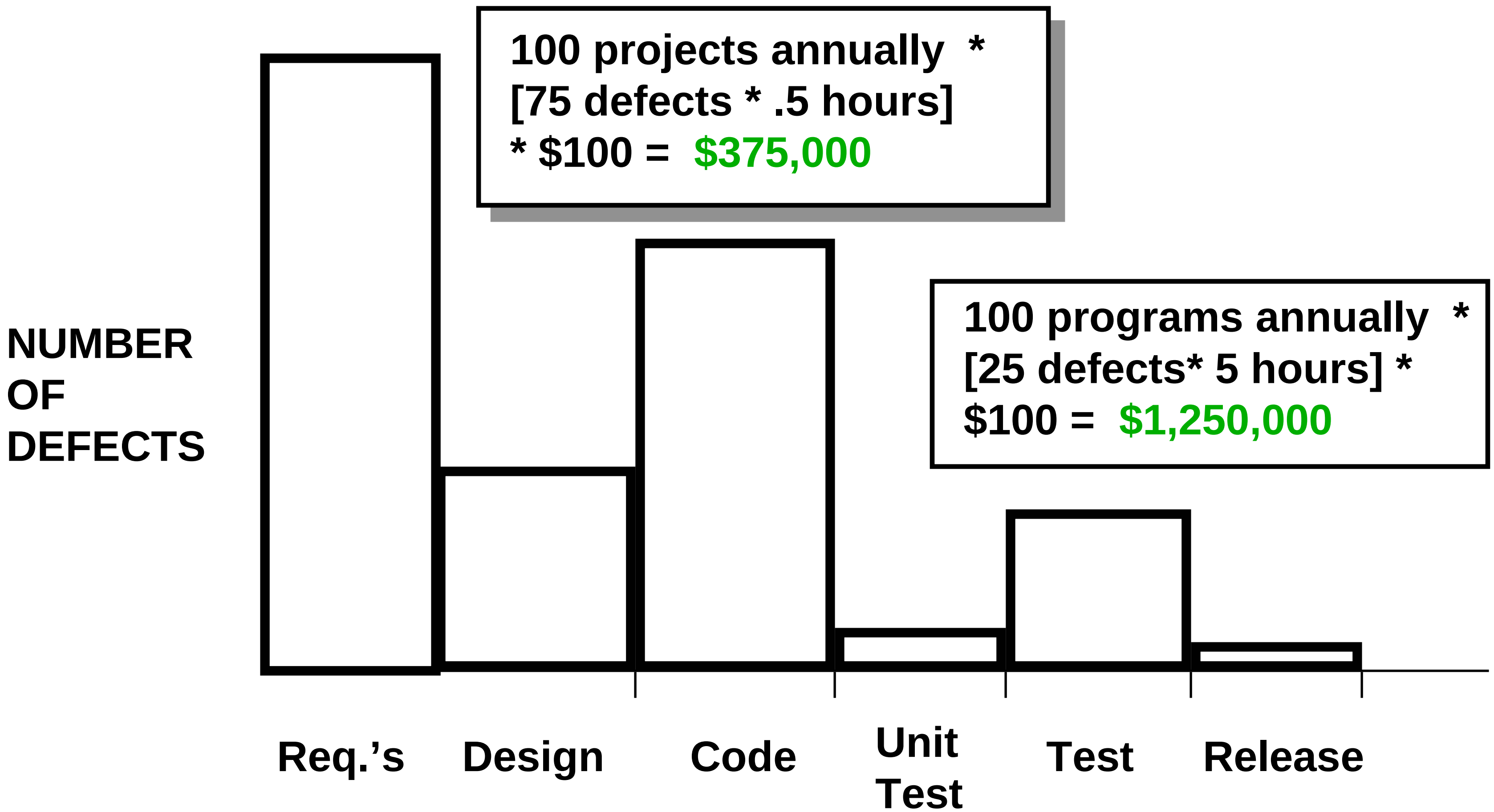
Our example will assume $100,000 was spent on EDD training.

Example Pre-EDD (0% DRE): Defect Dollarization



- Slide adapted from Olson, "A Software Quality Strategy for Demonstrating Early ROI", SSQ Journal, May 1995.

Example Post-EDD (75% DRE): Defect Dollarization



- Slide adapted from Olson, "A Software Quality Strategy for Demonstrating Early ROI", SSQ Journal, May 1995.

Average 7:1 ROI

Pre-EDD (100 Projects):

- **100 defects * 5 hours = 500 hours (50,000 hours)**
- **500 hours * $100 = $50,000 ($5,000,000)**

Post-EDD (100 Projects):

- **75 defects * 0.5 hours = 37.5 hours (3,750 hours)**
- **37.5 hours * $100 = $3,750 ($375,000)**

- **25 defects * 5 hours = 125 hours (12,500 hours)**
- **125 hours * $100 = $12,500 ($1,250,000)**

Investment: $475,000 ($100K Training + EDD Process)
Return: $5,000,000 - $1,725,000 = $3,275,000
ROI: $3,275,000 / $475,000 = 7:1 (100 Projects Annually)

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Summary

Most of industry "tests in quality", and testing in quality is expensive.

Early defect detection saves money, improves productivity, and reduces cycle time.

Best-in-class results are defect removal efficiency of 70-90% before testing.

In-Process inspections average 7:1 ROI which can be realized in less than 6 months.

Early defect detection and defect prevention are world-class strategies.

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Lessons Learned Preparing in Helping Large and Small Organizations prepare for their first SCAMPI[SM] appraisal

NDIA/SEI

CMMI® Technology Conference

November 14-17th, 2005

Robert J. Pomietto

Overview

- The Premise of this session
- The Problems
- The Result
- A Suggested Solution and Practice Implementation Indicator Descriptions (PIIDs)
- Recommendations
- Typical results in performing an organization's first appraisal (Backup Slides)

The Premise

The majority of early CMMI® presentations at previous conferences have been by organizations already familiar with the CMM and CMMI

- Many already at CMM of CMMI Maturity Level 3 or higher
- Many are Transition Partners with the SEI and have internal experts, appraisers, and instructors that are familiar with PIIDS

However other companies that do not have this experience reported on their experience transitioning to the CMMI and preparing for their first appraisal. This presentation reviewed four small and one large organization attempting to implement the CMMI. Several high level hurdles to overcome.

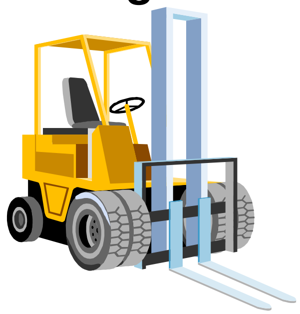
- Ability and effort to understand the new model
- Relative effort to convert their processes to be fully CMMI compliant using the PIIDs
- Effort to prepare for and undergo a SCAMPI^SM appraisal (A, B or C)

The Problem

Some Basic Problems in Implementing CMMI

Companies (Large and Small) reviewed are starting from the following premise:

- **They've have not paid the price to wrap up the learning curve on the model**
- **They have no infrastructure**
- **They have no lessons learned**
- **No monies allocated to sufficiently institutionalize practices and processes**
- **Lack of sufficient resources**
- **Unreal time frame expectations from senior management to achieve a Maturity or Capability Level**
- **Lack of senior management involvement to ensure progress is being made**



Some Basic Problems in Implementing CMMI (Cont'd -1)

- Project Managers are part of the technical project
- Process training (project management, process improvement and other appropriate training is not delivered in a timely fashion. This includes for example:
  - EPG training
  - MSG training
  - Process training
  - Estimation techniques
  - Quality Assurance auditing techniques
  - Measurement training
  - Project management training
  - Building schedules
  - Intro to CMMI course

Some Basic Problems in Implementing CMMI (Cont'd -2)

- EPG members do not understand their role; e.g., interfacing to the projects and the MSG
- People with the wrong skill sets are members of the EPG.
  - No software/systems engineering background
  - No interpersonal skills
  - No writing skills
  - No team building skills
  - Should have at least taken the Intermediate course and passed it. Of the five organizations in this study five members of the EPG took the Intermediate Concepts of CMMI course from the SEI and only two individuals on different EPG's passed it.
- They do not know what it takes to succeed in an appraisal and prepare their PIID documentation and personnel carefully for participation in the SCAMPI process

The End Result

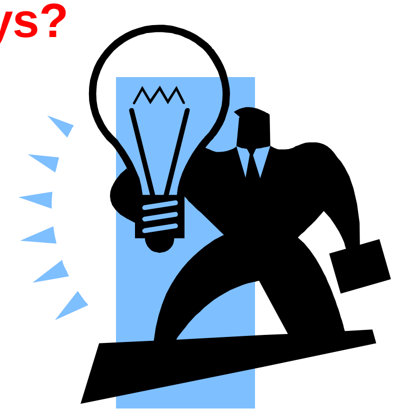
The End Result

If you are just starting out in process improvement, you will likely have quantitatively different experiences than you expect

- **Effort to understand the CMMI model will be greater without the CMM experience as a basis. This is particularly true with organizations dealing with services (Help Desks, Training Service projects)**
- **Mapping your practices to the model and preparing the PIIDS will be incomplete because your early understanding of the model is incomplete**
- **Preparing for an appraisal will consume a lot of resources(e.g. in one organization preparing and successfully passing a SCAMPI Class A appraisal took over 2,000 hours including project personnel from 3 projects)**

The End Result (Cont'd -1)

- Notifying the Lead Appraiser eight months ahead of time but having no time for the Lead Appraiser to review the CMMI Process Improvement Program. As a result when the Lead Appraiser does walk through the door for a SCAMPI Class C he/she finds that the entire process improvement program was placed in the hands of two EPG representatives. The results of the SCAMPI Class C showed a number of process problems relating to the Specific Practices in the Level 2 areas:
  - No processes/practices to deal with RTM's, scoping, estimating, measuring, quality assurance audits etc. Then the question is asked " Do you think we can meet our management goal of attaining a Maturity Level/Capability Level in 30 days?



The End Result (Cont'd -2)

- Asking a Lead Appraiser to perform a SCAMPI Class A in 30 days?
- What about those Practice Implementation Indicator Descriptions?
- Dealing with the results of the first appraisal can be catastrophic if you aren't prepared

Problems Preparing for the Appraisal – PIIDs (Cont'd –1)

CMMI appraisals are verification-based appraisals which rely on the organization identifying Process Implementation Indicator Descriptions (PIIDs) and collecting artifacts to prove the practices are implemented- not a discovery based effort (CBA-IPI or a SCE)

Immature organizations have trouble understanding how to fill out the PIIDs

- **Direct and Indirect Artifacts are confusing**
  - Object oriented practices vs. action oriented practices
  - One practice's direct artifact can be another practice's indirect artifact
- **A shotgun approach is used (list as many artifacts as you can think of)**
  - Usually none of the artifact(s) address the practice
- **Too general in terminology, not specific enough to show the practice is really implemented**
  - Meeting minutes, emails, action items
    - Actual examples of the above don't cover the practice in question

Problems Preparing for the Appraisal – PIIDs (Cont'd –2)

- Appraisal teams will spend an inordinate amount of time separating the appropriate artifacts from the rest and "discovering" the real state of process implementation with immature organization

Problems Preparing for the Appraisal/PIIDS - Politics

Organizations just starting out have a culture change problem to deal with

- **Managers don't want to air their dirty linen so they are reluctant to be appraised**
- **Project teams haven't really bought into the CMMI yet so they are reluctant to get involved**
- **Everybody is busy and the organization doesn't want to disturb the projects**
  - PIIDs will be filled out by a third party who's trained in the CMMI and in filling out PIIDs but without specific project knowledge, resulting in wasted effort trying to deal with the project team to get information

  or

  - PIIDs will be filled out by project team members that may not have been fully trained on what is needed, resulting in repeated requests for more/better information on the PIIDs by the appraisal team

Organizations, where we have performed appraisals, tend to fill out the PIIDs for PP and PMC with "Project Plan" listed as the Direct Artifact for each practice. The DAR Practice filled out the PIIDS with the DAR Plan for each practice.

A Suggested Solution and PIIDs

A Suggested Solution

A typical first step in most process improvement efforts (after the Introduction to CMMI training) is to map your practices against the CMMI to determine your objective evidence (PIID) gaps

- **Most organizations haven't documented their current practices**
  - It can be hard to tell what you do
  - It's easy to assume just because you know of a process, it's widely used in the organization
- **Most Level 1 organizations that have documented processes don't follow them**
  - They are not widely communicated
  - They are not integrated into a whole project "system" with supporting training, templates, and management encouragement
  - They are abandoned at the first sign of trouble

Using the Practice Implementation Indicator Descriptions (PIIDs) to help the team

Practice Implementation Indicator Descriptions (PIIDs)

- Practice implementation indicators are "footprints" which are evidence of the conduct or implementation of a practice.
- SCAMPI appraisals use practice implementation indicators as the focus to verify practice implementation.
- Verifying practice implementation is the review of Objective Evidence to determine whether a practice is implemented within a project and/or organization.

THE PROBLEM : "We really didn't understand the dynamics of the CMMI model until we tried to prepare the PIIDS for the appraisal."

Practice Implementation Indicator Description Types

Direct Artifacts

Indirect Artifacts

Affirmations

PIIDs include documents as well as information gathered from interviews with managers and practitioners.

Indicators provide a useful and reliable way of predicting that something is present or true.

Example: Automobile fuel gauge

Pros:

- **can highly simplify repetitive and costly operations**
- **can be great time savers**

Cons:

- **can be misleading**
- **can be wrong**

Direct Artifacts

- Tangible output(s) resulting directly from implementation of a specific or generic practice

- Integral part of verifying practice implementation

- May be explicitly stated or implied by the practice statement or associated informative material

Examples:

- Typical work products listed in CMMI practices
- Target products of an "establish and maintain" specific practice
- Documents, deliverable products, training materials, etc.

Indirect Artifacts

• Artifacts that are a consequence of performing a specific or generic practice or that substantiate its implementation, but which are not the purpose for which the practice is performed.

• That is, an artifact exists but there is no indication of where it came from, who worked to develop it, or how it is used.

• Examples:

Meeting minutes, review results, status reports, performance measures

Affirmations

• Oral (interviews) or written statements confirming or supporting implementation of a specific or generic practice

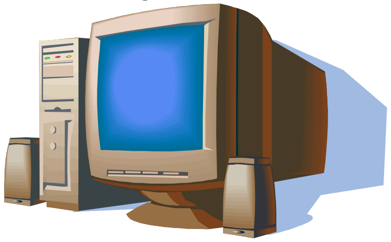
• Usually provided by the practice implementers or other stakeholders

• May include interviews that are face-to-face, video conference or teleconference, or equivalent

Recommendations

Recommendations for preparing PIIDs from performing SCAMPI's with mature/immature organizations

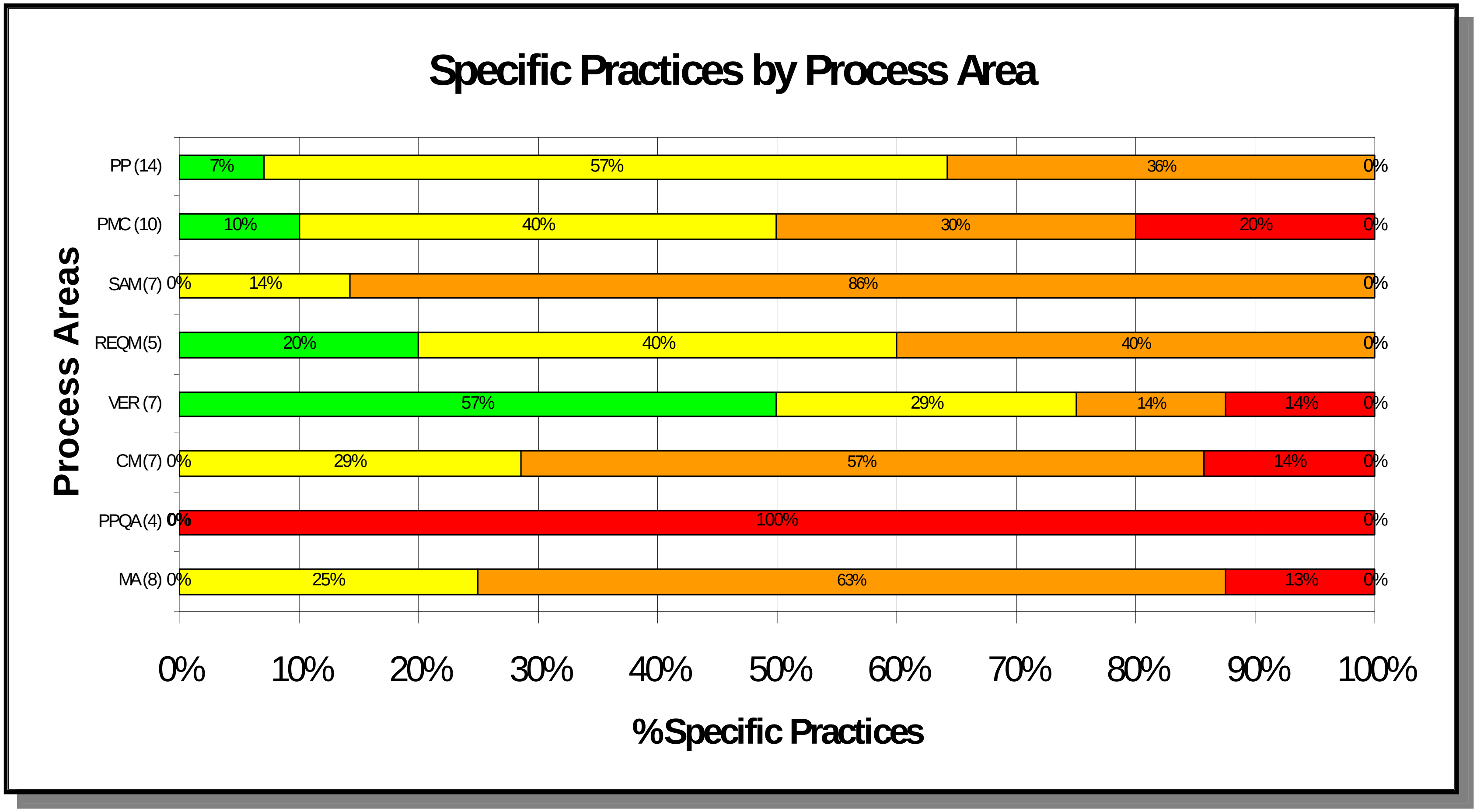
- **Mature organizations usually have employed one of the following techniques to resolve PIID issues:**
  - Provide a **"Process Improvement" Coach** to help the project teams resolve the direct vs. indirect objective evidence problem
  - An **Organization Process Group** that provides direction through a series of workshops
  - **"Tiger Team"** approach with projects
  - Bimonthly reviews of PIIDS by PPQA
  - Organizational PPQA provides oversight in conjunction with monthly reviews with Project Status reviews to senior management



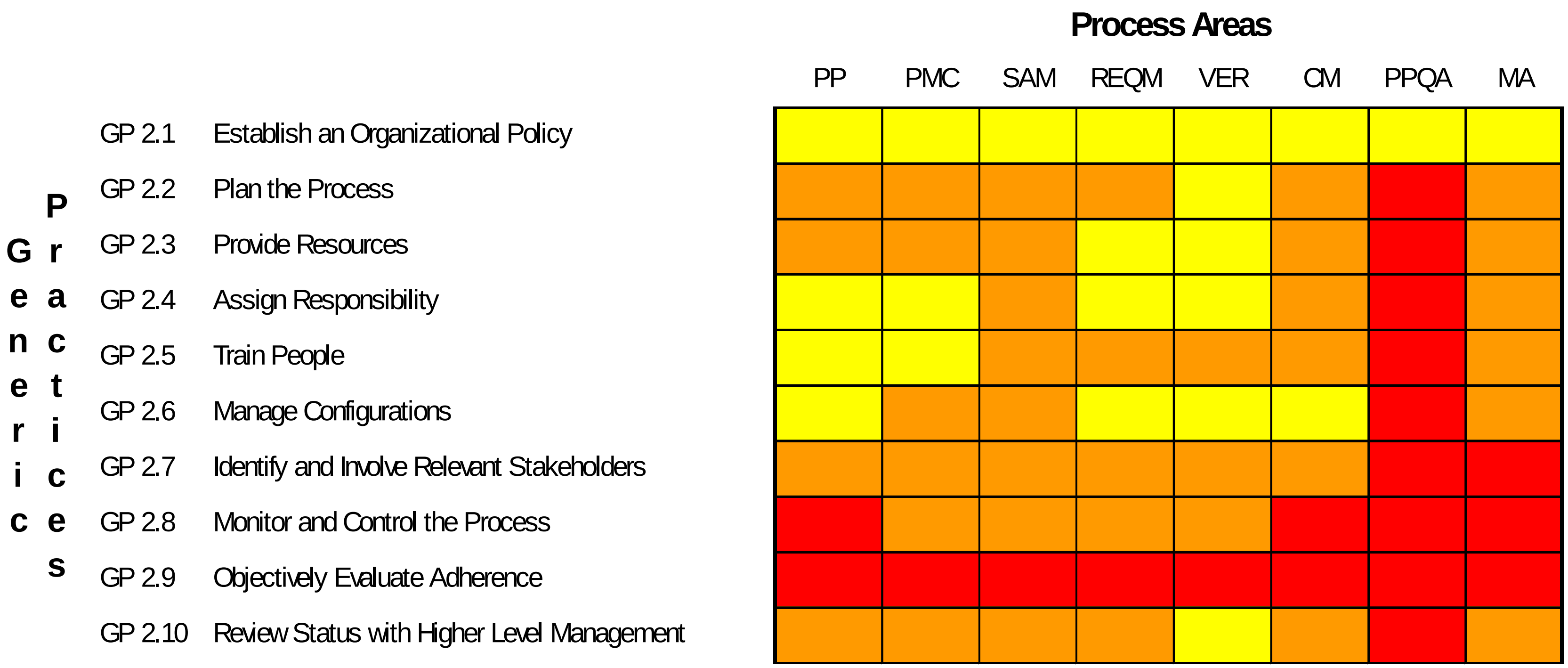
Recommendations for preparing PIIDS from performing SCAMPI's with immature/mature organizations

- **Most Immature organizations do not dedicate the resources to Process Improvement to effectively fill out the PIIDS**
  - Work allocation is in the range of 10-20% of time allocated to process improvement- the rest is billable/project work
  - No understanding of the model
  - The EPG has little experience in process improvement
  - Do not have the CMM background to fall back on in terms of what is involved in process improvement
  - Time allowed by management to fill out PIIDS is minimal

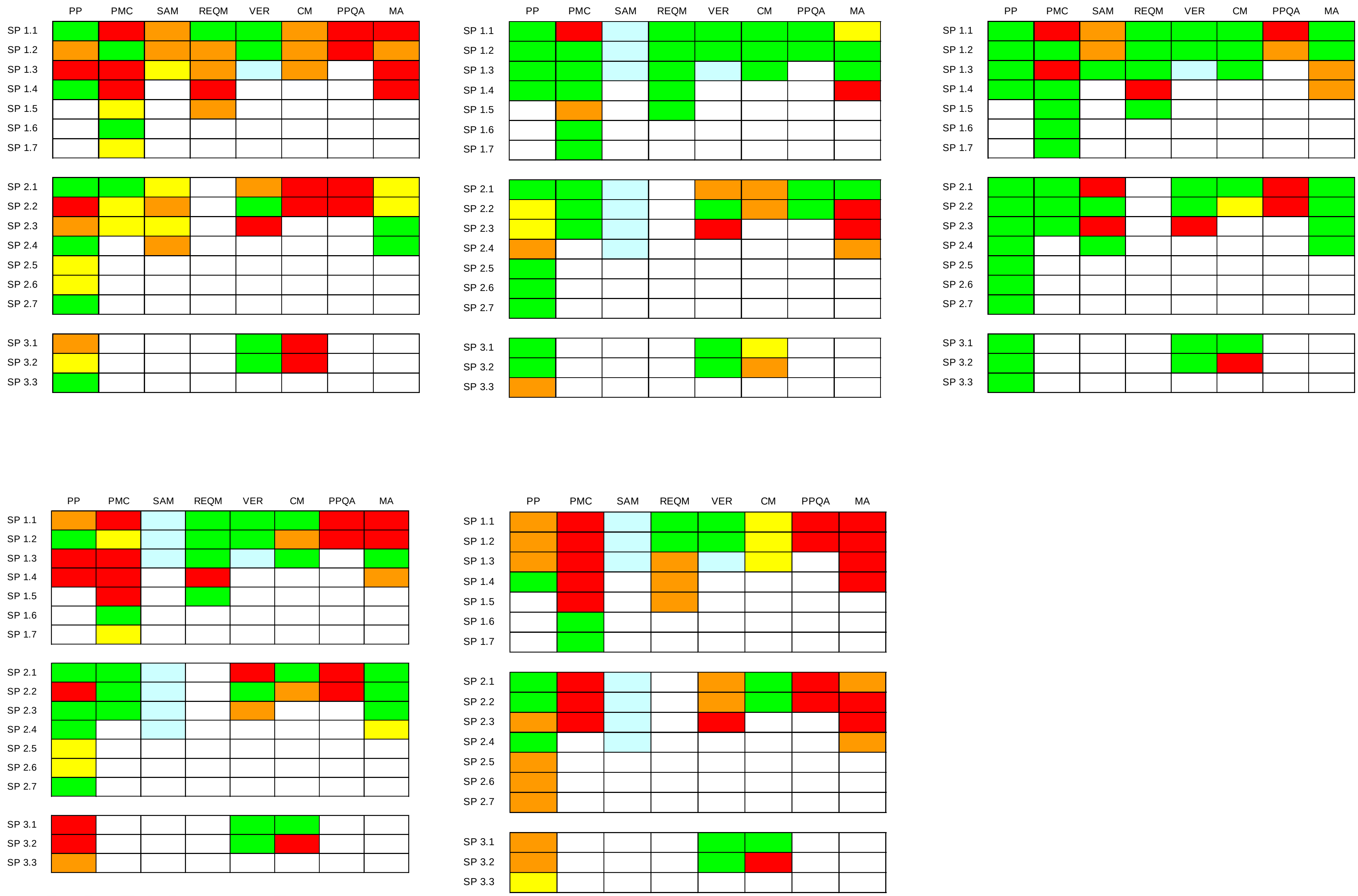
Typical First Appraisal (Class C w/5 projects)



Typical First Appraisal (Class B w/5 projects)



Different Views – Specific Practices SCAMPI Class B – Can you tell which organizations were prepared?



Any Questions or Comments?

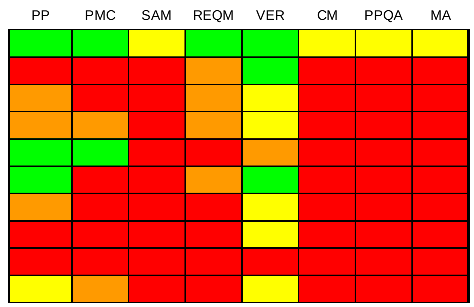
Backup -Sample PIIDs Results

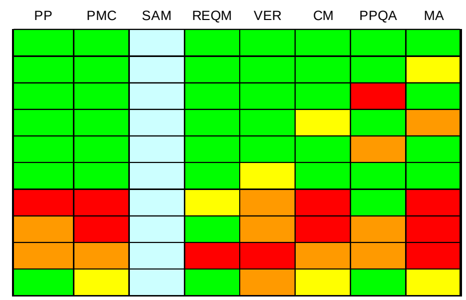
Interpreting the Results

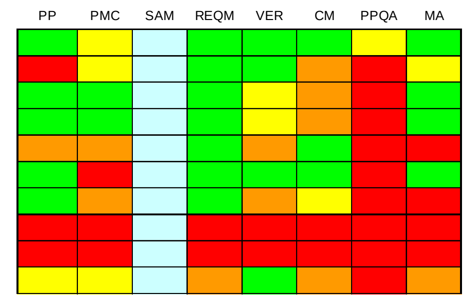
Fully Implemented (FI)	**•Direct artifacts present and appropriate** **•Supported by indirect artifact and/or affirmation** **•No weaknesses noted**
Largely Implemented (LI)	**•Direct artifacts present and appropriate** **•Supported by indirect artifact and/or affirmation** **•One or more substantial weaknesses noted**
Partially Implemented (PI)	**•Direct artifacts absent or judged inadequate** **•Artifacts or affirmations indicate some aspects of the practice are implemented** **•One or more substantial weaknesses noted** *Projects that have not reached the point in the life cycle to have produced the necessary direct artifacts are rated PI and this would be accounted for when the instantiations are aggregated at the OU level practice rating.
Not Implemented (NI)	Any situation not covered by above

Different Views – Generic Practices

GP 2.1 Establish an Organizational Policy
GP 2.2 Plan the Process
GP 2.3 Provide Resources
GP 2.4 Assign Responsibility
GP 2.5 Train People
GP 2.6 Manage Configurations
GP 2.7 Identify and Involve Relevant Stakeholders
GP 2.8 Monitor and Control the Process
GP 2.9 Objectively Evaluate Adherence
GP 2.10 Review Status with Higher Level Management







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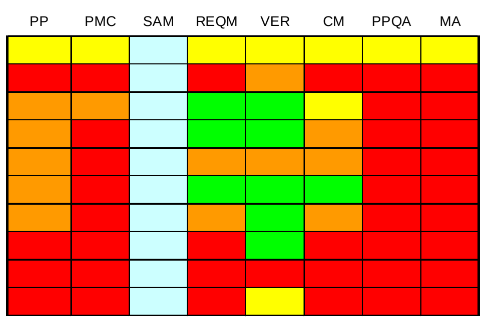
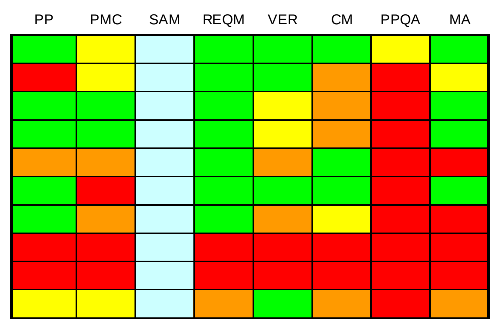
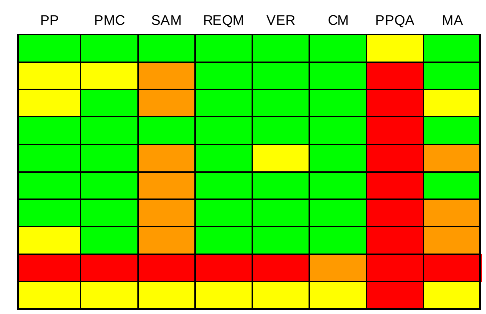






SCAMPI Class A Level 3 SE/SW Goal Profile (3rd effort towards achieving a Maturity Level 3)

ORGANIZATIONAL UNIT CHARACTERIZATION AND GOAL/PA RATING MAP
(actual Assignments)

Process Area >>>>>>>>>	Practice >> / Goal	|	x.1	x.2	x.3	x.4	x.5	x.6	x.7	x.8	x9	x.10	x.11	x.12
RD	SG1	S	FI	FI										
RD	SG2	S	FI	FI	FI									
RD	SG3	S	FI	FI	FI	FI	FI							
RD	GG3	S	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI
TS	SG1	S	FI	FI	FI									
TS	SG2	S	FI	FI	FI	FI								
TS	SG3	S	FI	FI										
TS	GG3	S	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI
PI	SG1	S	FI	FI	FI									
PI	SG2	S	FI	FI										
PI	SG3	S	FI	FI	FI	FI								
PI	GG3	S	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI
VER	SG1	S	FI	FI	FI									
VER	SG2	S	FI	FI	LI									
VER	SG3	S	FI	FI										
VER	GG3	S	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI
VAL	SG1	S	FI	FI	FI									
VAL	SG2	S	FI	FI										
VAL	GG3	S	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI
OPF	SG1	S	FI	FI	FI									
OPF	SG2	S	FI	FI	FI	FI								
OPF	GG3	S	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI
OPD	SG1	S	FI	FI	FI	LI	FI							
OPD	GG3	S	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI
OT	SG1	S	FI	FI	FI	FI								
OT	SG2	S	FI	FI	FI									
OT	GG3	S	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI
IPM	SG1	S	FI	LI	FI	FI	FI							
IPM	SG2	S	FI	FI	FI									
IPM	SG3	NA	NA	NA										
IPM	SG4	NA	NA	NA	NA									
IPM	GG3	S	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI
RSKM	SG1	S	FI	FI	FI									
RSKM	SG2	S	FI	FI										
RSKM	SG3	S	FI	FI										
RSKM	GG3	S	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI
IT	SG1	NA	n											
IT	SG2	NA												
IT	GG3	NA												
ISM	SG1	NA												
ISM	SG2	NA												
ISM	GG3	NA												
DAR	SG1	S	FI	FI	FI	FI	FI	FI						
DAR	GG3	S	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI	FI
OEI	SG1	NA	NA	NA	NA									
OEI	SG2	NA	NA	NA	NA									
OEI	GG3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

1 organization

Evaluating the Impact of New Tools and Technologies Using Simulation

David M. Raffo, Ph.D., Portland State University
Tim Menzies, Ph.D., Portland State University

Agenda

- Motivation
- Learned Defect Detectors Highlights
- Process Simulation Highlights
- Model Overview
- Three Scenarios and Results
- Conclusions

Motivation

- Good new technologies are wasted
  - unless there is a compelling business case to use them
- Without such a case:
  - Managers not convinced
  - No reallocation of scarce resources
- Good technology: data mining defect detectors
  - increased PDs (probability of detection)
  - Lower PFs (probability of false alarm)
  - Lower inspection effort (more time for other, more specialized methods
- This talk:
  - The business case
  - Developed via process simulation

Data mining defect detectors

- Data miners learn detect detectors from static code measures (McCabe and Halstead)at the module level.
  - Not perfect: widely deprecated (Shepherd, Fenton, and others)
  - Adequate as partial indicators (but watch that false alarm rate)

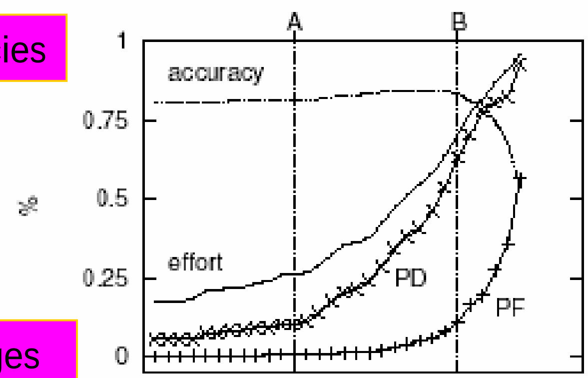
has defect

No	Yes	
A	B	detector silent
C	D	detector triggered

accuracy= (a+d)/(a+b+c+d)
pd = detection (or recall)
= d/(b+d)
pf = false alarms = c/(a+c)
prec = d/(c+d)
Effort = (C.loc + D.loc)/
(ABCD.loc)

Stable accuracies

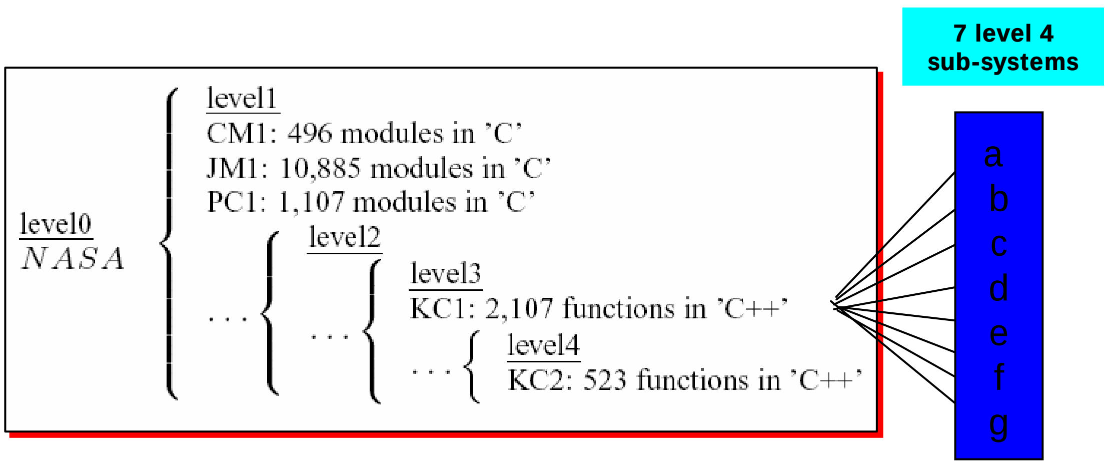
Massive changes in other measures

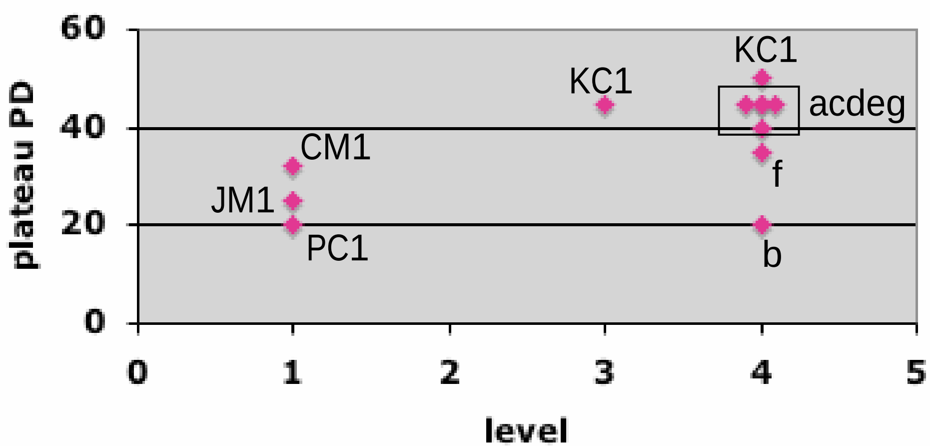


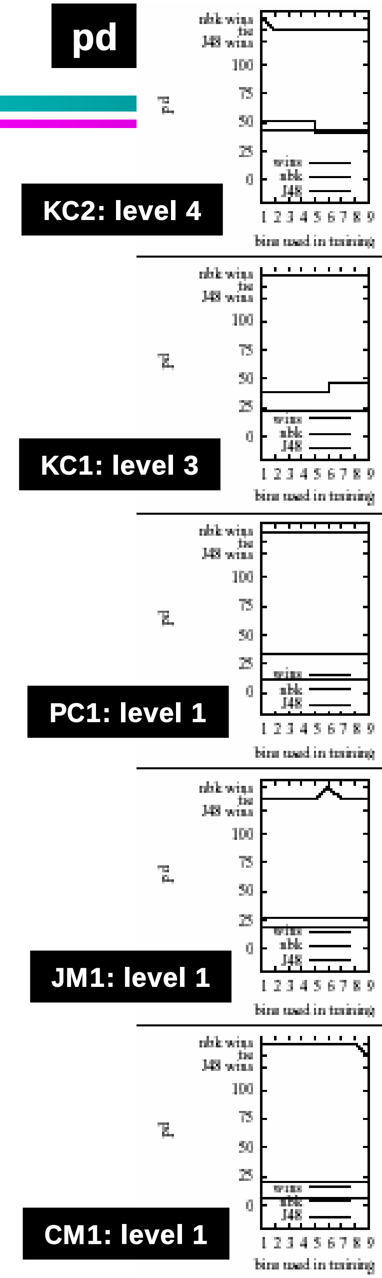
30 detectors, sorted by effort

Results

- NBK will suffice (in 85% cases NBK same or better than J48)
- Early plateaus (50-200 examples are enough)
- Not shown: low PFs
- Stratification improves PD?







- Suggestive, not conclusive evidence for "stratification improves PD"

But, so what?

Is any of the above useful?

Introducing - Process Simulation

- One area that can help companies improve their processes is ***Process Simulation***.
- Process Simulation supports organizations to address
  - Strategic management
  - Process Planning
  - Control and operational management
  - Technology adoption
  - Understanding
  - Training and learning
  - Quantitative process management and other CMMI-Based Process Improvement

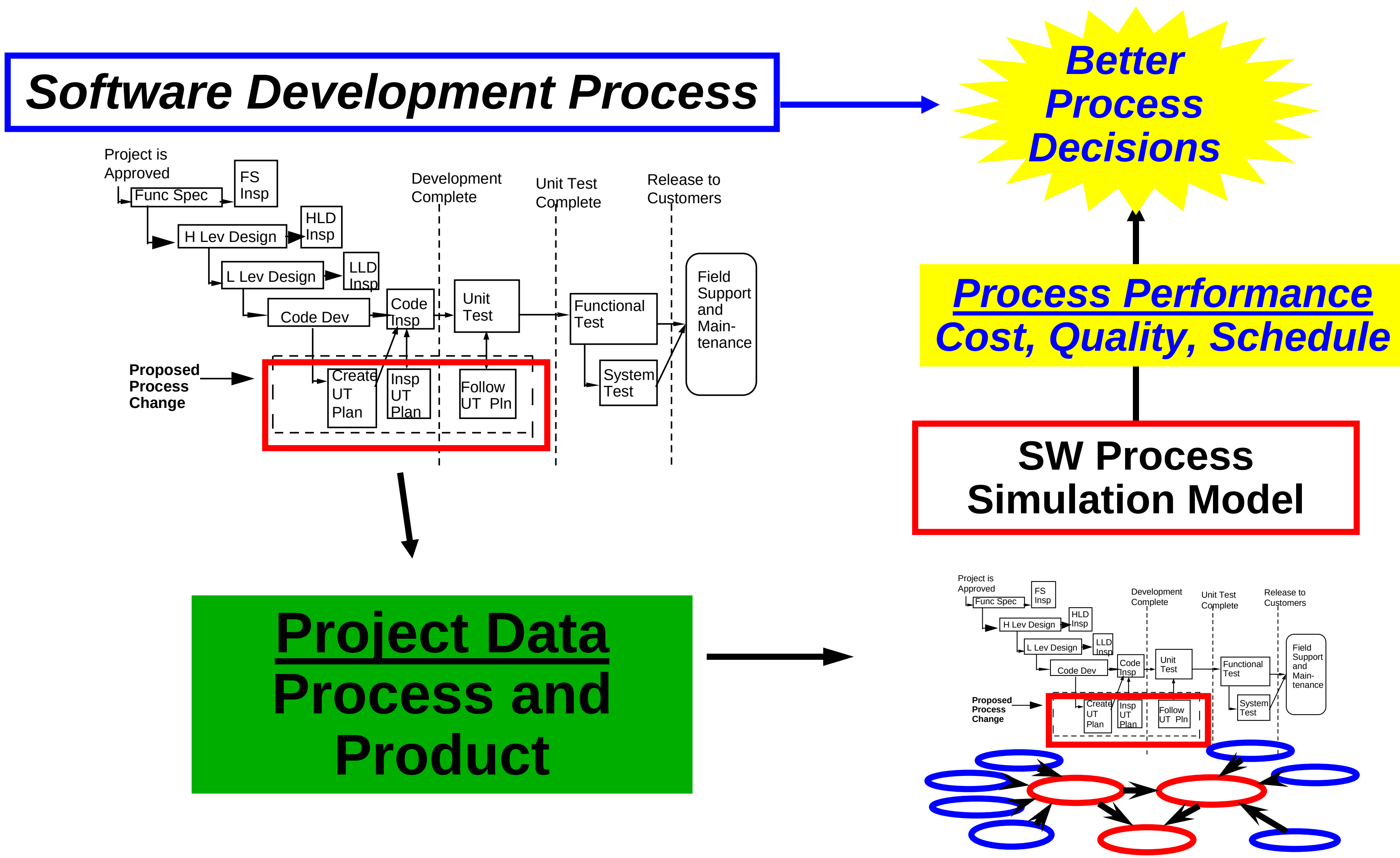
Features of Process Simulation and PTAM

- **Based on extensive research**.
- **Graphical user interface** and models software processes
- **Utilizes SEI methods** to define SW Processes
- **Integrates metrics** related to cost, quality, and schedule into understandable performance picture.
- **Predicts project-level impacts** of process improvements in terms of cost, quality and cycle time
- **Support business case analysis** of process decisions - ROI, NPV and quantitatively assessing risk.
- **Designed for Rapid Deployment**

Importance/Benefits – Enduring Needs

- NASA Project Level
  - Software Quality Assurance Strategy Evaluation for NASA Projects
  - Independent Bottoms-Up NASA Project Cost Estimation (Going where COCOMO cannot – KSC project)
  - NASA Contractor Bid Evaluation (NASA IV&V integrated part of Planning and Scoping/Cost Estimation strategy)
  - Software Assurance Replanning
  - Cost/Benefit Evaluation of new technologies and tools

How it works


Software Development Process
Better Process Decisions
Project is Approved
Func Spec
FS Insp
H Lev Design
HLD Insp
L Lev Design
LLD Insp
Code Dev
Code Insp
Development Complete
Unit Test
Unit Test Complete
Functional Test
System Test
Release to Customers
Field Support and Main-tenance
Proposed Process Change
Create UT Plan
Insp UT Plan
Follow UT Pln
Process Performance
Cost, Quality, Schedule
SW Process Simulation Model
Project Data
Process and Product

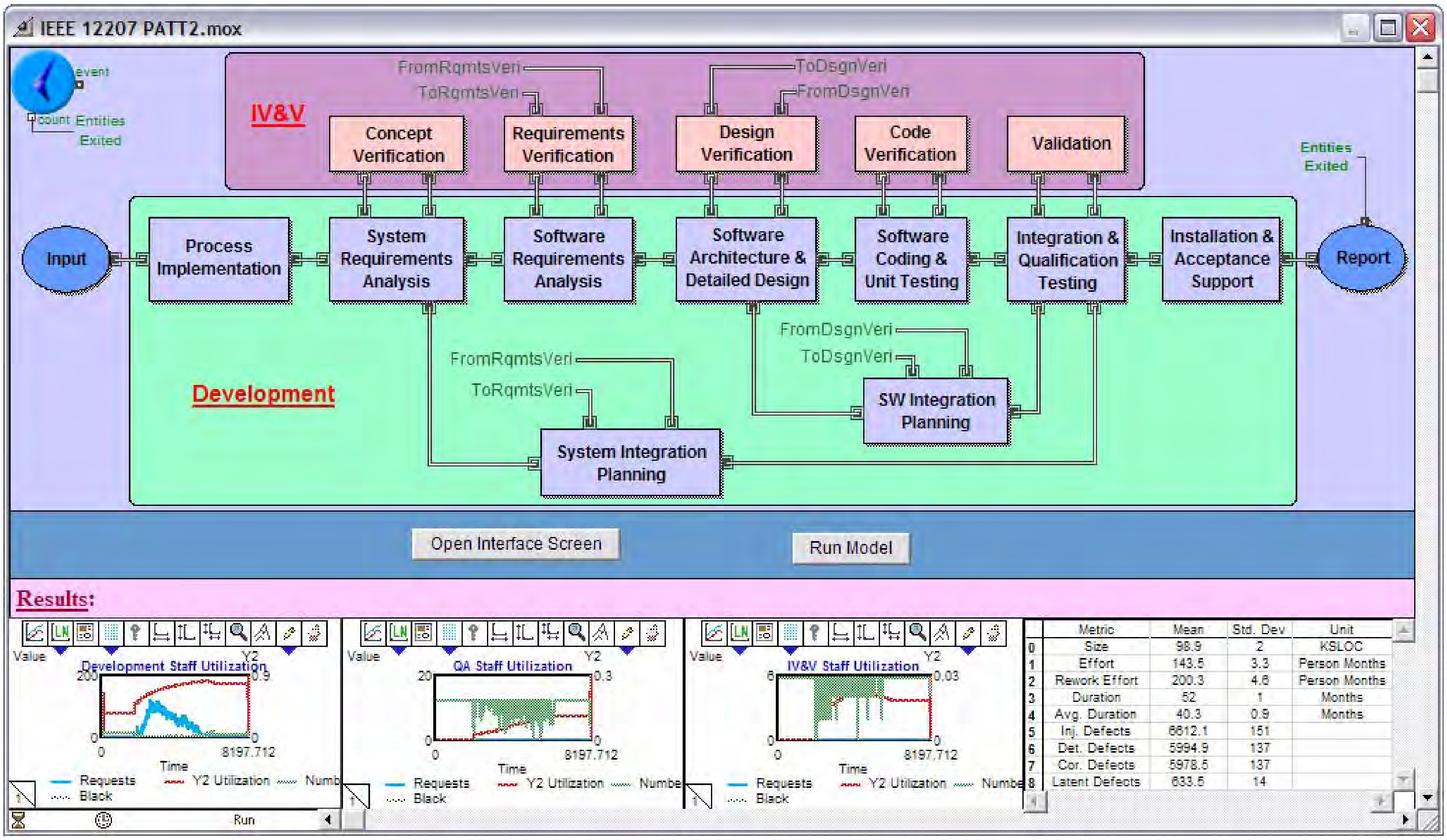
Goal

- In this presentation, we assess the impact of a new technology (i.e. Learned Defect Detectors) on a “typical” large-scale NASA project in terms of overall cost, quality and schedule performance
- Goal: To determine when the new technology might be ***useful*** and when they might be ***useless*** by providing a business case to support the adoption of these tools.

Business Case Questions

- What is the impact of applying new tools and technologies?
- What is the economic benefit or value of the tool or technology? What is the ***Return on Investment***?
- Under what conditions does the tool or technology perform best? Under what conditions does it perform poorly?
- What performance standards does the tool need to achieve in order to have a positive performance impact on the project/organization?
- Are there alternative ways to apply the tool or technology that enable it to provide a more positive impact?

NASA Model – Includes IV&V Layer with IEEE 12207 Software Development Lifecycle



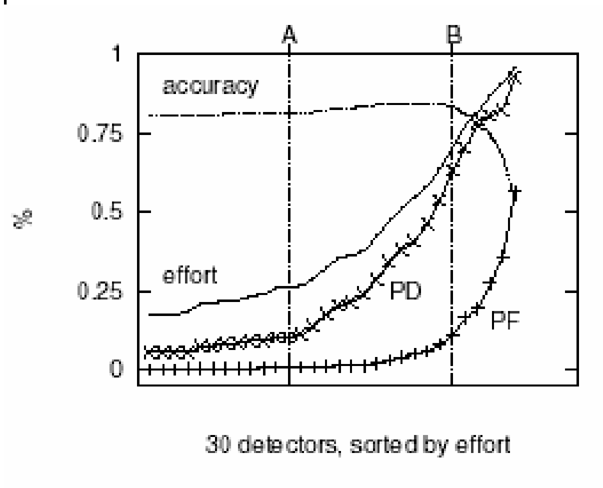
IV&V Layer – Select Criticality Levels for IV&V Techniques using pull-down menus

Notebook - IEEE 12207 PATT2.mox

		Concept Verification		Requirements Verification		Design Verification		Code Verification		Validation	
ID	IV&V Technique	Consequence	Error Potential	Consequence	Error Potential	Consequence	Error Potential	Consequence	Error Potential	Consequence	Error Potential
1.1	Management and Planning of Independent Verification and Validation	None	None	None	None	None	None	None	None	None	None
1.2	Issue and Risk Tracking	None	None	None	None	None	None	None	None	None	None
1.3	Final Report Generation	None	None	None	None	None	None	None	None	None	None
1.4	IV&V Tool Support	None	None	None	None	None	None	None	None	None	None
1.5	Management and Technical Review Support	None	None	None	None	None	None	None	None	None	None
1.6	Criticality Analysis	None	None	None	None	None	None	None	None	None	None
1.7	Identify Process Improvement Opportunities in the Conduct of IV&V	None	None	None	None	None	None	None	None	None	None
2.1	Reuse Analysis	None	None								
2.2	Software Architecture Assessment	None	None								
2.3	System Requirements Review	None	None								
3.1	Traceability Analysis – Requirements			None	None						
3.2	Software Requirements Evaluation			None	None						
3.3	Interface Analysis – Requirements			None	None						
3.4	System Test Plan Analysis			None	None						
4.1	Traceability Analysis – Design					None	None				

Assumptions

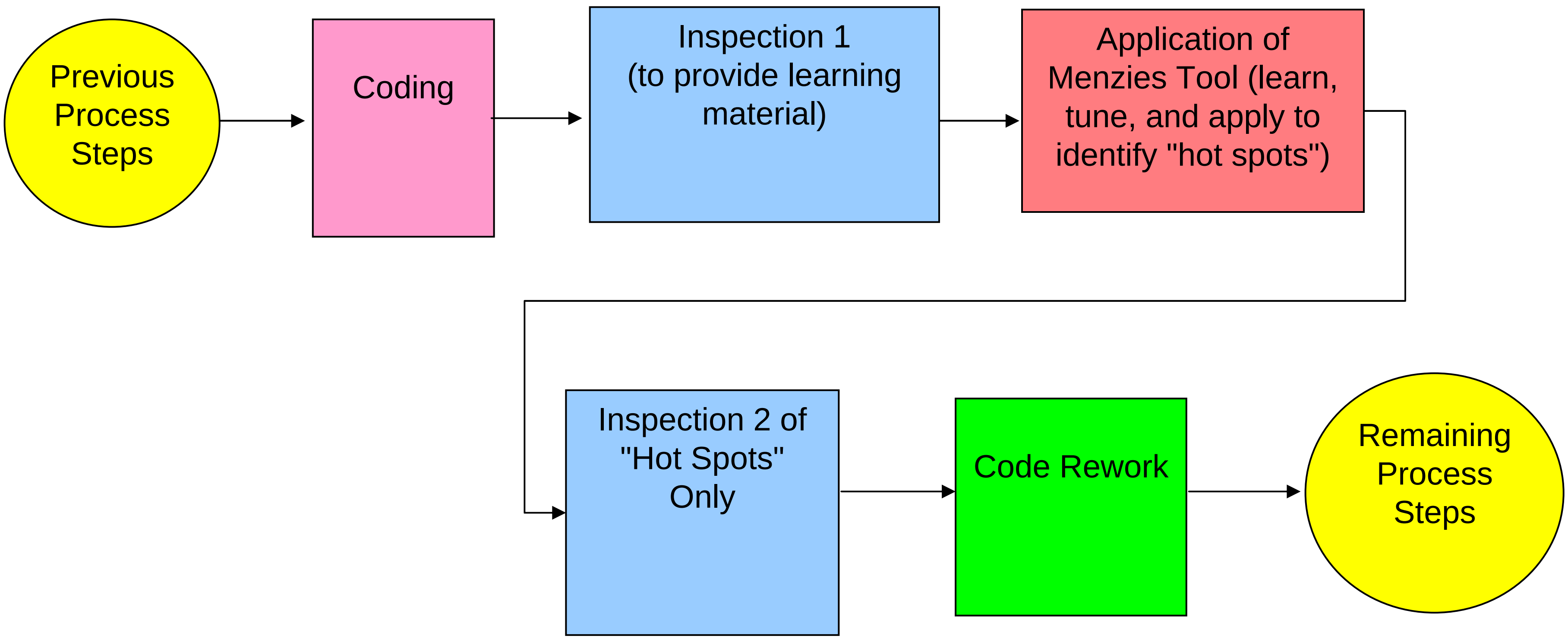
- Project Size is 100 KSLOC.
- Software process follows the IEEE 12207+IV&V model. True for many DoD and NASA projects.
- %LOC Inspected=PD+5% to 10%; and %LOC is proportional to Effort
- PF = 10%-30%.
- PD=40 to 70%.
- The PD rate assumes, in turn, that defect detectors are learned from data divided below the sub-system level.
- Standard manual inspections find 40% to 60% of the total defects.
- Perspective Based inspections find 80% to 90% of latent defects
- Defects uniformly distributed throughout code



Scenario I - Applying LDD to V&V

- Learned defect detectors are applied during project V&V.
  - Inspections are conducted on 11.5% of code to learn defect detectors
  - LDDs then applied to remaining code to identify high-risk portions of the system
  - Explored the impact of using higher PD combined with higher PF
  - Explored the impact of using regular inspections(weak training set) vs Perspective Based inspections (strong training set) for LDDs.

Changes to the Process



Scenario I - Results Summary

- Model recommendations for specific scenarios
- General Rule:

  Insp Effect* %Code_Inspected*95%<= E_LDD* TS_IE

Where:

Insp Effect – Probability of detection of V&V inspections

%Code_Inspected - % of code inspected during V&V

E_LDD – Probability of Detection for LDDs

TS_IE – Probability detection of Training Set inspections

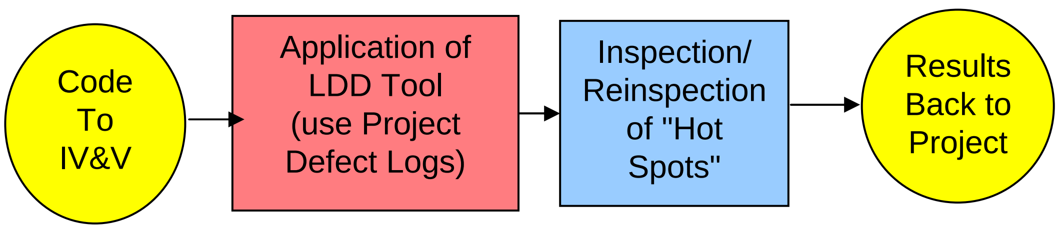
Scenario I - Results Summary

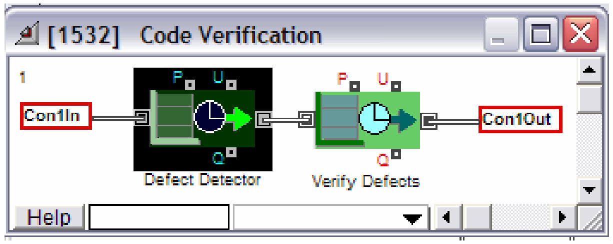
- LDDs are ***Useful*** (Significant benefits) in a V&V setting when:
  - 53% or less of the code is inspected during V&V (manned vs unmanned missions) using regular inspections and LDD PD =50%
  - Using high PD mode and Perspective based inspections
  - Project inspections are poor
- Applying LDDs to V&V are ***Useless*** when:
  - Project inspections are good or high quality
  - More than 53% of the code is inspected by V&V (typical for manned missions)

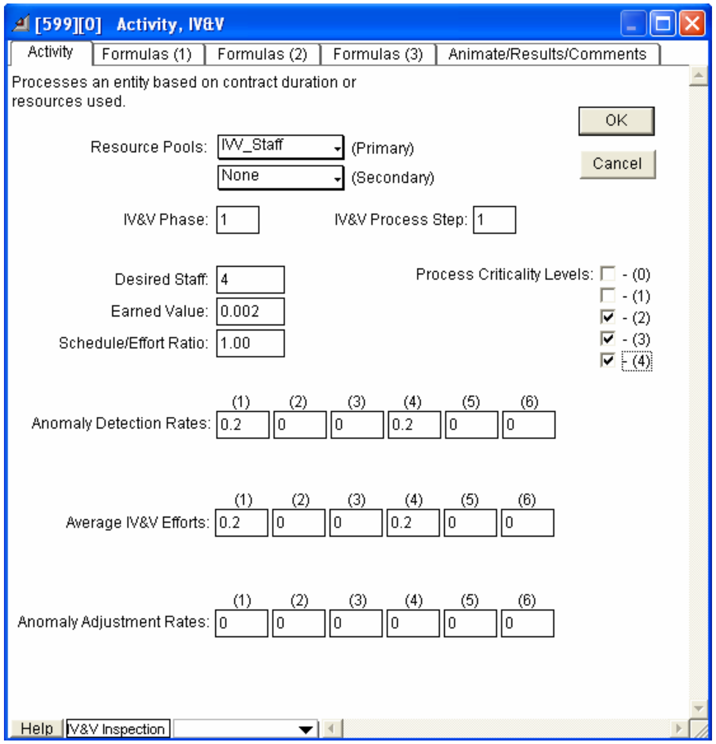
Scenario II - Applying LDD to IV&V

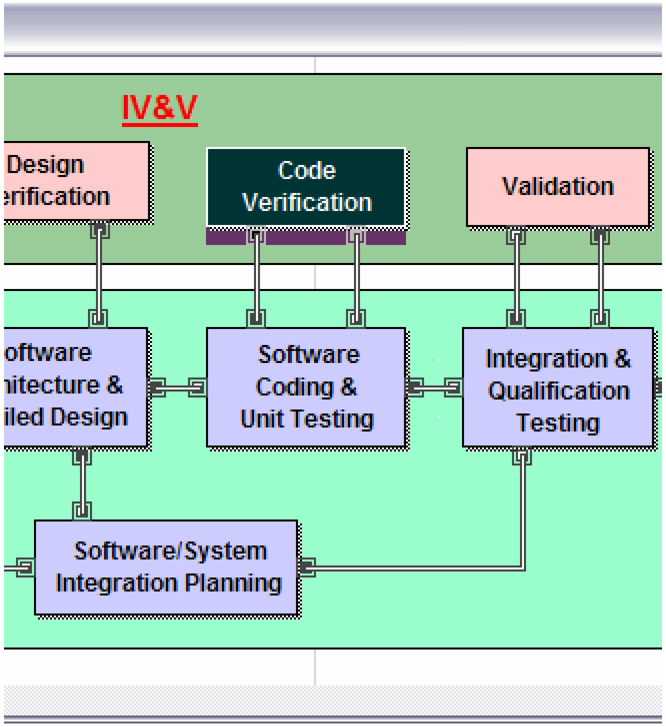
- Learned Defect Detectors (LDD) applied to IV&V (Shedding light on blind spots)
  - Project generated training sets (regular inspections)
  - Investigated the Impact of applying LDD to different project types (varied amount of code that is reinspected (100%-25%))
  - Varied the effectiveness of reinspection (2%-10%)

Changes to the Process – IV&V









Scenario II - Results

- Clear recommendations for specific scenarios
- Results (Excellent Application):
  - Low Risk = 1.2 PM with no defects detected
  - Improves quality if any defects are found (detection capability > 0)
  - Receive added assurance even if detection capability is 0
  - For Manned Missions, (100% reinspection), break-even on total project effort if IV&V reinspection effectiveness = 2%
  - Significantly improves cost, quality and schedule if reinspection effectiveness is >= 5%

Scenario II - Results

- Significant up side potential when LDDs are used to identify high risk portions of the code that were not previously inspected during project level V&V (unmanned missions).
- At 50% code inspected by V&V, 4%-7.5% reduction in delivered defects
- At 25% code inspected during V&V, reductions in delivered defects range from 15%-24%. Effort savings range from 18 PMs to 29 PMs.

Conclusions

- Learned Defect Detectors ***are useful*** when they ***increase*** the overall detection capability of the Coding phase.
- General Rule:
- Insp Effect* %Code_Inspected*95%<= E_LDD* TS_IE
- This occurs when:
  - Less than 53% of code is inspected during V&V or V&V has week inspections
  - Used as IV&V technique identifying blind spots and augmenting regular high-quality V&V
  - V&V has weak inspections

Conclusions

- Learned Defect Detectors ***are useless*** when they ***decrease*** the overall detection capability of the Coding phase.
- This occurs when:
  - Used to frivolously cut costs by replacing high quality code inspections.

Conclusions – Broader Impacts

- Identify the conditions under which application of a new technology **would be** beneficial and when applying this technology **would not be** beneficial.
- We can define ***performance benchmarks*** that a new tool or technology needs to achieve.

Conclusions – Broader Impacts

- We can ***diagnose problems*** associated with implementing a new tool or technology and ***identify new ways*** to apply the technology to the benefit of the organization (and the vendors)
- Finally, we can do all this ***before*** the technology is purchased or applied and therefore can save scarce resources available for process improvement.

The End

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CMMI Process Improvement – Its not a Technical Problem, it's a People Problem!

5th Annual CMMI Technology Conference

November 16th, 2005

Rolf W. Reitzig

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Integrated Software Engineering

Successful Businesses...

- Run operations as if they were a franchise
  - Every business process is standardized
  - Average employees can easily be successful by following the processes as outlined
  - Everyone knows how to perform their job
  - Tasks are performed similarly on a repeatable basis

- <u>A quality process will yield a quality product</u>

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Questions to Ask…

- What is the quality of your delivered software?
- Are your software projects meeting estimated delivery dates?
- What visibility do you have into your software projects?
- What confidence do you have in delivering a quality software system on time on budget?
- How do you know if your software projects are performing well?
- What is your cost of software quality?

What is Software Process Improvement (SPI)

- A planned, managed, and controlled effort aimed at improving an organization's software development capability
- Is most effective when coupled with Organizational Transformation best practices

Return On Investment

- Organizations typically invest 2%-4% of their IT budget on software process improvement
- Organizations engaged in a software process improvement effort experience 50%+ gains in productivity and a 25%+ decreases in post-release defects
- Average ROI was 5:1
- Example: An IT department with a $100M budget spending $4M on SPI can expect a $20M gain in productivity over 2 years

The 6 Basic Principles of SPI

1. Major changes to the software process must start at the top
2. Effective change requires a goal and knowledge of the current process
3. Software process improvement requires investment
4. Ultimately, everyone must be involved
5. Software process changes will not be retained without conscious effort and periodic reinforcement
6. Change is continuous

Source: Humphrey, W.S. *Managing the Software Process.* Addison-Wesley, 1989

Other Key Concepts

1. To improve the software process, someone must work on it
2. Unplanned process improvement is wishful thinking
3. Automation of a poorly defined process will produce poorly defined results
4. Improvements should be made in small, tested steps
5. Train, train, train!

Source: Humphrey, W.S. *Managing the Software Process.* Addison-Wesley, 1989

Organizational Transformation

- Software process improvement models build on organizational transformation theory to ensure effectiveness.
- Thus, it is imperative to understand organizational transformation theory in order to improve the results of any software process improvement effort.

Organizational Transformation Models

- Initiating, Diagnosing, Establishing, Acting, Leveraging (IDEAL)
- Unfreeze, move, refreeze
- Envisioning, Encoding, Enacting
- Awareness, Understanding, Definition, Installation, Adoption, Institutionalization
- John Kotter’s Model of Organizational Transformation

John P. Kotter's Transformation Best Practices

1. Establish a sense of urgency
2. Create the guiding coalition
3. Develop a vision and strategy
4. Communicate the change vision
5. Empower employees for broad-based action
6. Generate short-term wins
7. Consolidate gains and produce more change
8. Anchor new approaches in the culture

Source: John P. Kotter, Leading Change, Harvard Business School Press, 1996

1 – Establishing a Sense of Urgency

- Progression to subsequent organizational transformation phases is difficult, if not impossible, unless most managers honestly believe that the status quo is unacceptable

2 - Creating the Guiding Coalition

- Successful transformations must be guided by a powerful coalition that can act as a team
- The coalition is needed because no one individual has the information needed to make all major decisions or the time and credibility needed to convince lots of people to implement the decisions

3 – Developing a Vision and Strategy

- Vision refers to a picture of the future with some implicit or explicit commentary on why people should strive to create that future.
- 3 purposes
  - Clarifies the general direction for change
  - Motivates people to take action
  - Coordinates the efforts of different people
- Must be conveyable in 5 minutes or less

4 – Communicating the Change Vision

- The real power of a vision is unleashed when most of those involved in an enterprise have a common understanding of its goals and direction
- You cannot undercommunicate the vision!
- A common mistake by the guiding coalition is to assume the organization can quickly come to grips with the vision

5 – Empowering Employees for Action

- Major organizational transformations rarely happen unless many people assist
- Employees generally won't help if they feel relatively powerless

6 – Generating Short-Term Wins

- Major changes take time
- People need to see convincing evidence that the effort is paying off
- Focus on short-term wins raises the urgency level and ties the transformation effort to the vision and strategy

7 – Consolidating Gains/Creating More Change

- If the sense of urgency is lowered, critical momentum can be lost and regression follows
- Irrational and political resistance to change never fully dissipates
- Avoid the temptation to “take a break”
- Leadership must keep a long term focus on the vision and anticipated results

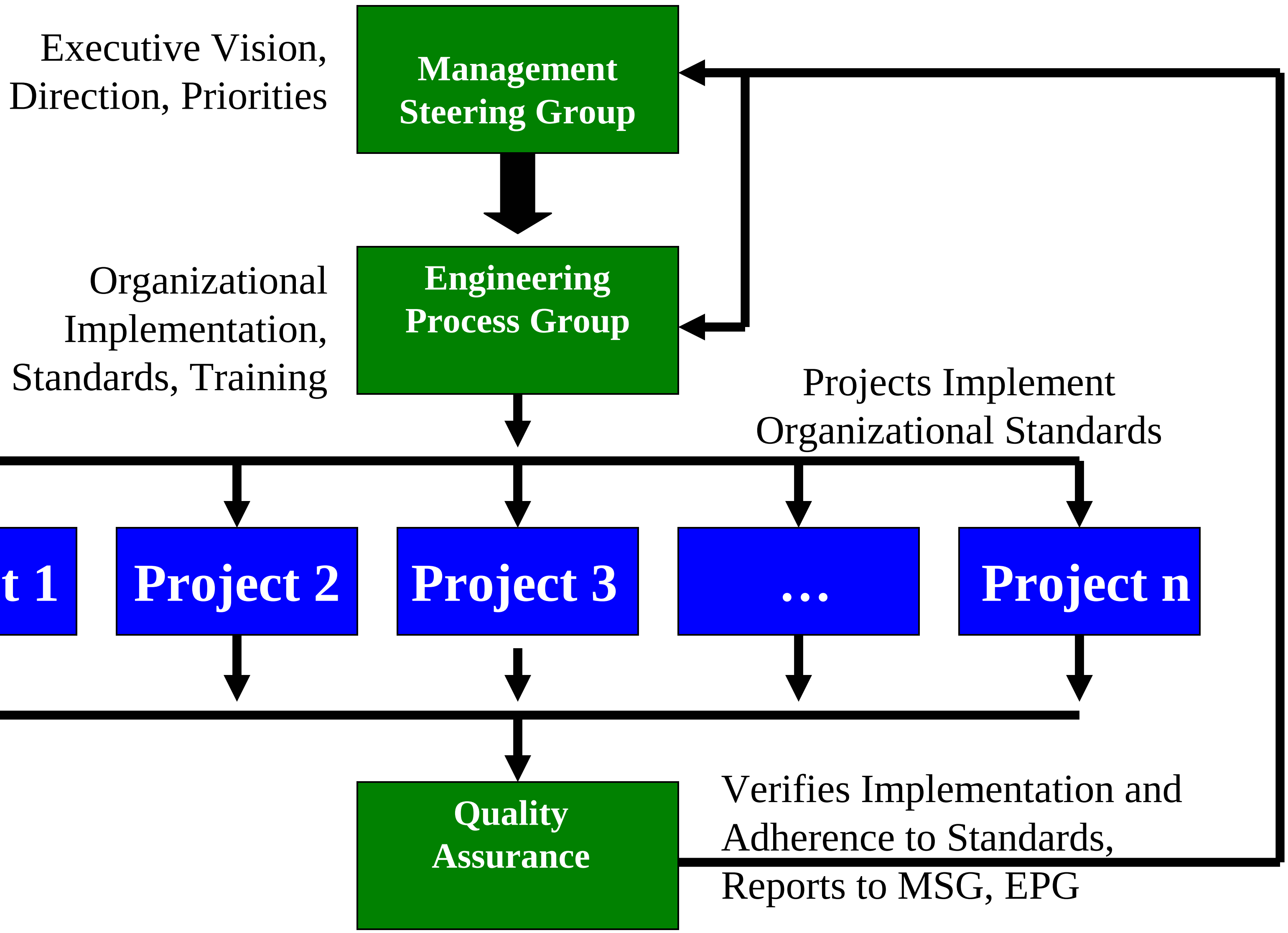
8 – Anchoring New Approaches in the Culture

- The goal is to permanently change the organization's shared values
- Cultural changes come last, not first
- Cultural norms are many times difficult to change
- Cultural shared values are extremely difficult to change
- Will the transformation effort transcend any particular individuals???

How Do We Transform SW Engineering?

- Create an infrastructure that:
  - Leverages organizational transformation principles
  - Allows for senior management prioritization of software development process enhancements
  - Facilitates organizational buy-in and cooperation
  - Encourages cross-organizational communication
  - Reduces resistance through a reward system based on independently verifiable achievement of management's expectations
  - Allows management visibility into the use of standard software development processes

Organizational Transformation Infrastructure



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Roadmap – Setting the Stage

1. Establish Executive Sponsorship with the expectation it is <u>active</u>, not passive
2. Clearly tie the improvement effort to business goals
3. Establish a guiding coalition (MSG/EPG) of movers and shakers from across the organization to drive the strategy, approach, and plan
4. Projectize the effort, assign a cost center, and treat it like a project with clear milestones and reviews
5. Conduct a comprehensive process, project, personnel, and financial appraisals to establish an organizational baseline
6. Tie process improvement objectives to each individual's performance review

Roadmap – Introducing Improvements

7. Establish a measurement capability early, but don't overwhelm projects with data gathering requirements
8. Establish QA early to help guide and mentor, and to report process improvement-related progress
9. Ensure project schedules going forward contain all the required elements to meet your CMMI improvement objectives
10. Either adopt processes (that meets your needs!), or have the EPG design ones that are better suited
11. Projects execute CMMI-compliant processes and begin performing better!
12. Continue to monitor key business measures, execute QA, and conduct senior management reviews to drive urgency.

End Result

- The outcome will be an integrated, organizationally cooperative infrastructure that:
  - is the foundation for a successful organizational transformation
  - facilitates software process improvement based on consensus priorities
  - provides an environment that supports project buy-in and adoption of improvements
  - communicates effectively across the organization
  - reports results to senior management

Questions?

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Merging Measurement in Mature Companies

NDIA 5th Annual CMMI Technology Conference & User Group

November 14-18, 2005

Denver, CO

Peter J. McLoone, Mary Lynn Penn, and Sharon L. Rohde

Lockheed Martin Integrated Systems & Solutions (IS&S)

L

Topics

- Introduction
- Approach for Merger & Integration
- Methods Used
- Artifacts Analyzed
- Risks
- Findings
- Best Practices
- Causal Analysis & Actions

Lockheed Martin IS&S

Lockheed Martin Integrated Systems & Solutions (IS&S) specializes in developing horizontally-integrated solutions for network-centric operations, so that systems allow defense and intelligence organizations to act with greater speed, precision and effectiveness than ever before.

Approach for Merger & Integration

- Company A + Company B => Company C
- Analyzed artifacts, noted Best Practices
- Identified risks, documented mitigation plan
  - Included change management of many cultures
- Developed Transition Plan and Schedule
- Conducted Kickoff
- Implemented Plan according to schedule

Methods Used

- **Analyzed artifacts from two heritage Measurement Programs**
  - Comprehend
  - Contrast and compare
  - Developed mappings, tracking spreadsheets
- **Conducted Technical Interchange Meetings (TIMs)**
- **Provided clarifications**
- **Documented analysis**
- **Briefed results**

Artifacts Analyzed

- Policies
- Processes
- Procedures
- Manuals
- Forms
- Quantitative Management Plan (template)
- Training
- Boundary dependencies

Risks

- ***Assume all programs participate in merger.***
- ***Some programs may not be able to address some requirements or there may be unexpected actions that cannot be completed in a timely manner.***
- ***Of greatest risk were those programs and companies recently acquired that may not have been operating at a high level of maturity. Typically, they may not have yet assimilated the requisite process and culture changes.***

Findings (1 of 2)

- ***Program Profile database***
- ***Program Process Standard with supporting procedures***
- ***Process Asset Library, available to all***
- ***Different measurements for program types***
- ***Inspection Process as a critical subprocess across the life cycle***
  - *Defect Density, Prep & Pace rates are statistically managed using Statistical Process Control (SPC)*

Findings (2 of 2)

- *Process Performance Baselines reported*
- *Standard accounting system for labor*
- *User Survey – Effectiveness of Indicators*
- *Proposal support and cost estimation*
- *Corrective Action Request process and database*
- *Subject Matter Experts in Measurement support to corporate organizations*

Best Practices

- Measurement Program Steering Committee (MPSC)
- Executive Process Steering Committee (EPSC)
- Quantitative Management Manual (QMM)
- Hands-on with program Level 4&5 activities
- Checkpoint-driven collection of program data sets
- Inspection Tracking Tool (ITT)
- Integrated Program Environment (IPE) web sites for collaboration

Causal Analysis & Actions

- Re-charter MPSC to expand responsibilities
- Conduct across-company reviews of QMPs and monthly Measurement Reports, submit examples to Best Practices Library
- Provide additional training – QM, SPC
- Automate annual Survey to encourage participation
- Conduct on-going TIMs with boundary groups

Questions & Answers

So You Expect Me to use a CMMI Level 3 Process to achieve CMMI Level 3?

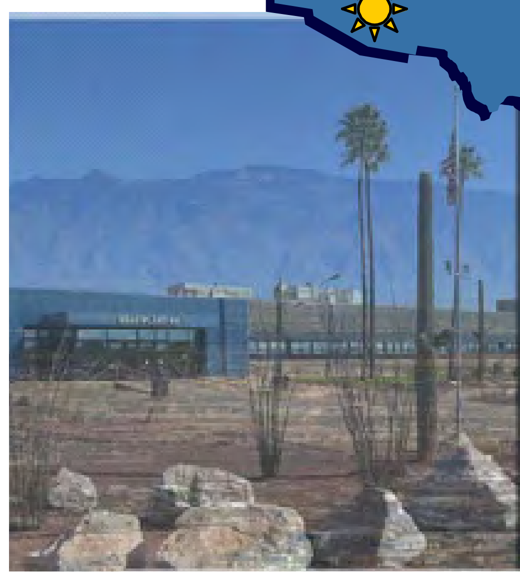
Raytheon Missile Systems
Steve Ross and Kurt McMillen

November 2005

Organization and Accomplishments

Raytheon Missile Systems, Tucson, AZ

- **Employees: 11,000**
- **’04 Sales: $3.8 B**
- **Worlds Largest Appraised SEI CMMI Level 3 Organization December 2004**
- **SW-CMM Level 5 in November 2001**



The Case for Change:
Our “Burning Platform” Was Ablaze . . .

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December 2003 Class 2 Appraisal – A long way to go!

	Maturity Level																	
	Level 2							Level 3										
Goals	REQM	PP	PMC	SAM	MA	PPQA	CM	RD	TS	PI	VER	VAL	OPF	OPD	OT	IMP	RSKM	DAR
GG3	F	F	F	F	F	E	E	D	F	D	D	D	F	F	D	F	E	F
GG2	F	E	E	E	F	E	D											
SG4																		
SG3		C					E	C	F	D	B						D	
SG2		E	D	D	E	E	B	D	F	F	C	C	F		C	F	E	
SG1	F	F	C	C	E	E	E	D	F	E	C	D	F	F	D	F	D	C

And we were the remaining RMS business unit not appraised to CMMI Level 3 . . .

And The Pressure Was On . . .

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Customer Satisfaction	Growth	People	Productivity
• Know our customers and understand their needs • Always perform to our commitments • Grow strong trusting relationships at all customer levels • Be accountable for the entire product life cycle	• Engage our customers and suppliers in partnerships for success • Fulfill evolving Warfighter requirements with innovative technology, products and solutions • Leverage company-wide capabilities • Grow programs and presence worldwide • Create new business opportunities from innovative ideas	• Ensure a respectful, productive and safe environment • Improve our culture by valuing diversity • Develop and recognize people • Take personal responsibility for open and honest communication	• Maintain an unrelenting focus on affordability and cycle time in everything we design and produce • Drive speed and agility through R6σ, IPDS, Commonality and Process Improvement • Meet financial goals • Drive Supply Chain excellence • Achieve CMMI Level 3
Be a Customer-Focused Business	*Provide Superior Solutions for the Warfighter*	*Help Each Other Succeed*	*Drive Performance Excellence*

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Missile Systems

The Epiphany

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Q: If IPDS @ RMS is our set of best practices for planning and executing complex missile programs, why aren't we using it to plan and execute our CMMI Level 3 Project?

We had the guidance in place (a subset):

- **Creation of IPDS @ RMS Tailoring**
- **Program Leadership, Planning and Support**
- **Program Resourcing, Financial Planning and Management**
- **Program Monitoring and Control**
- **Gate Independent and Start-Up Reviews**
- **Supporting Processes**
  - **Configuration and Data Management, Measurement and Analysis, Objective Evaluation, Peer Review, Risk Management**
- **The "Organizational Level Stuff"**
  - **Organizational Process Focus, Organizational Training . . .**

It is NOT "rocket science"; every type of project should be able to leverage the defined enterprise process

A Short Course on IPDS @ RMS: The Top-Level View

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A Short Course on IPDS @ RMS: Our Process Architecture

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A Short Course on IPDS @ RMS: Our Tailoring Guidance

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Raytheon Home | Directory | Search | Newsroom | Collaboration | Help

IPDS @ RMS

IPDS @ RMS | Storyboard | Index | Process Asset Library | Tailoring Tool | RMS CMMI

- CMMI @ RMS
- Corporate IPDS
- IPDS @ RMS Feedback/CR Tool
- IPDS @ RMS Contacts
- Missle Systems Home

IPDS @ RMS Components

- Storyboard
- Storyboard Index
- IPDS @ RMS PAL
- Program Tailoring
- Tailoring Tool
- Tailoring Tool User Guide
- Program Planning Playbook

IPDS @ RMS Program Tailoring

The purpose of IPDS @ RMS Tailoring is to particularize the common processes defined in IPDS @ RMS to a specific program instantiation that meets the program's unique needs. The tailoring activity results in an initial program IMP/IMS and information can be included in other program plans. An integrated, web based Tailoring Tool is provided to allow program managers and planners to easily tailor IPDS @ RMS tasks and methods to create program planning structures. The tailoring tool readily exports the

Our CMMI L3 Project Architecture: The Appraisal Objectives and Scope

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- **Objectives**
  - **Review IPDS @ RMS process content and its implementation against the CMMI-SE/SW model V1.1 (Staged Representation)**
  - **Identify process and deployment weaknesses**
  - **Measure performance against CMMI Level 3**
- **Organization Being Appraised**
  - **Raytheon Missile Systems**
- **CMMI Scope**
  - **All CMMI Level 2 and Level 3 Process Areas**

A daunting task based upon the complexity of the RMS organization

So How Do We Get There From Here? Our Roadmap

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- Tailor IPDS @ RMS
- Plan the project
  - Establish / prioritize tasks and their relationships
  - Identify and assign resources, roles, responsibilities and authority
  - Train the team and clearly communicate required work products and criteria for success
- Project start-up review (Gate 5 IR and Review)
- Manage execution of plans and track progress against plan
- Manage risks and take action as appropriate
- Objectively evaluate adherence to product & process requirements
- Review status with upper management
- Identify improvement opportunities

A very typical project plan

CMMI Level 3 Project Tailoring: Our Concept of Operations

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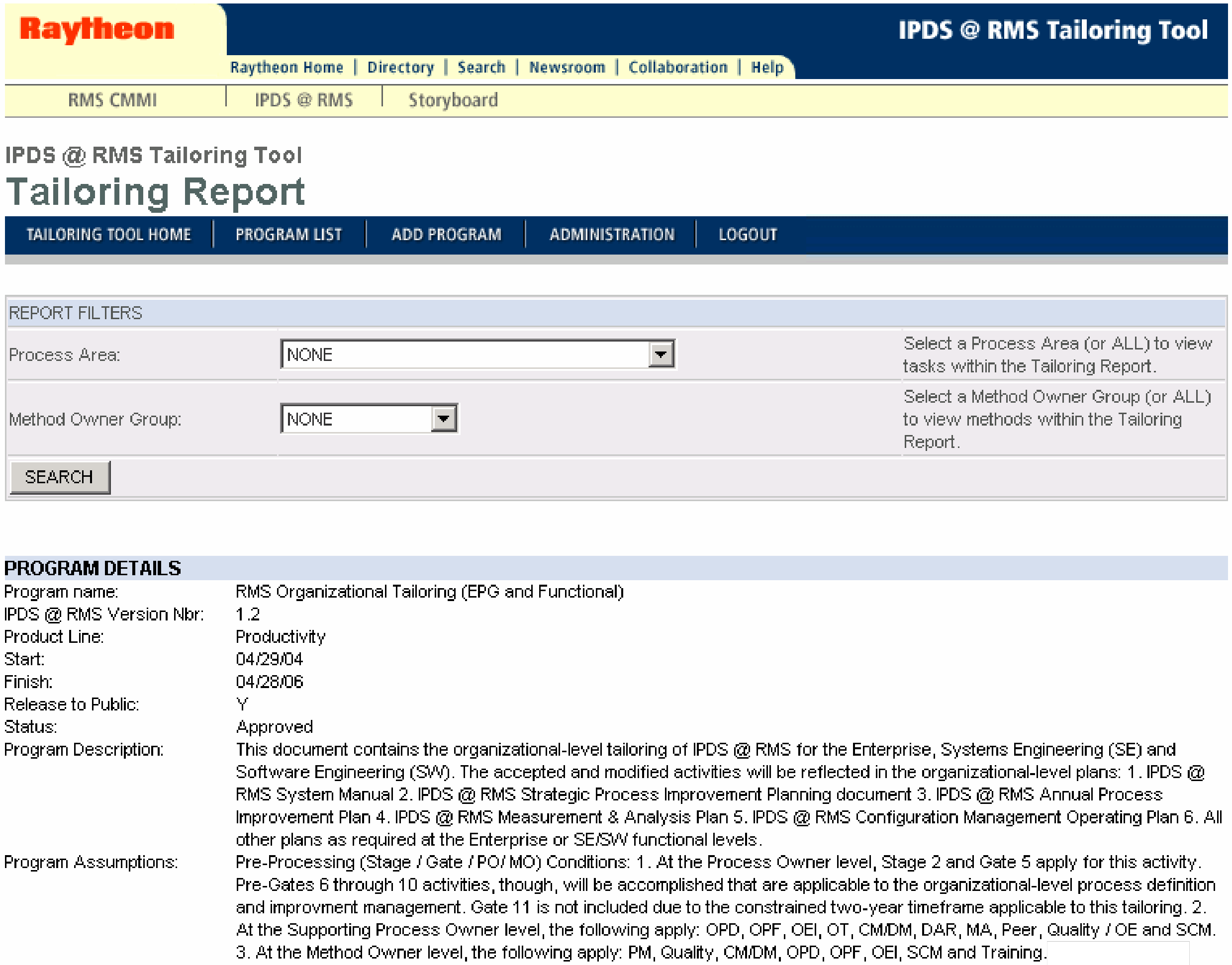

We were able to perform significant "pre-processing"

The Tailoring and Planning Result: Our Organizational "Plan Tree"

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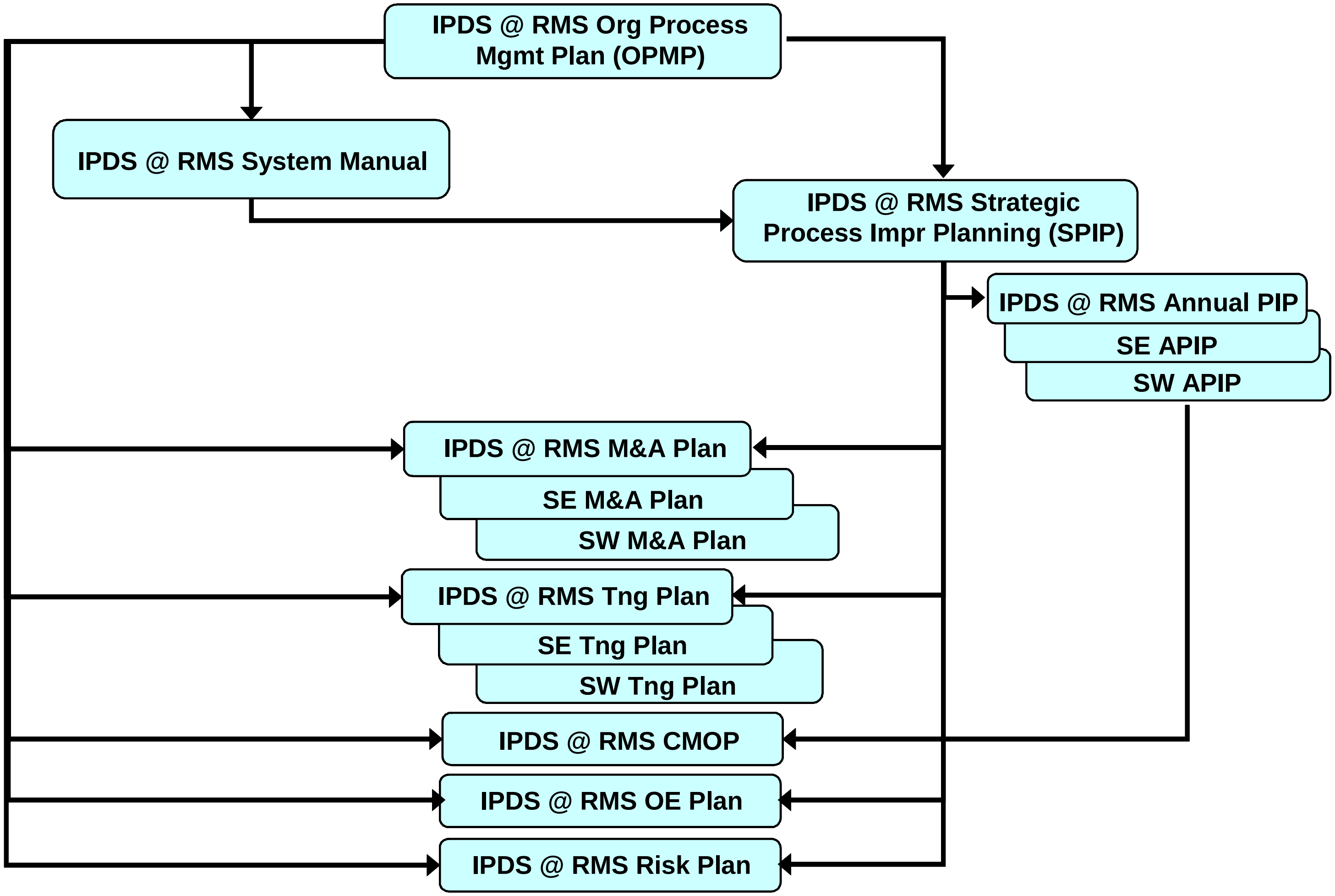

And we executed to our plans

The Tailoring and Planning Result: Our Project Master Schedule

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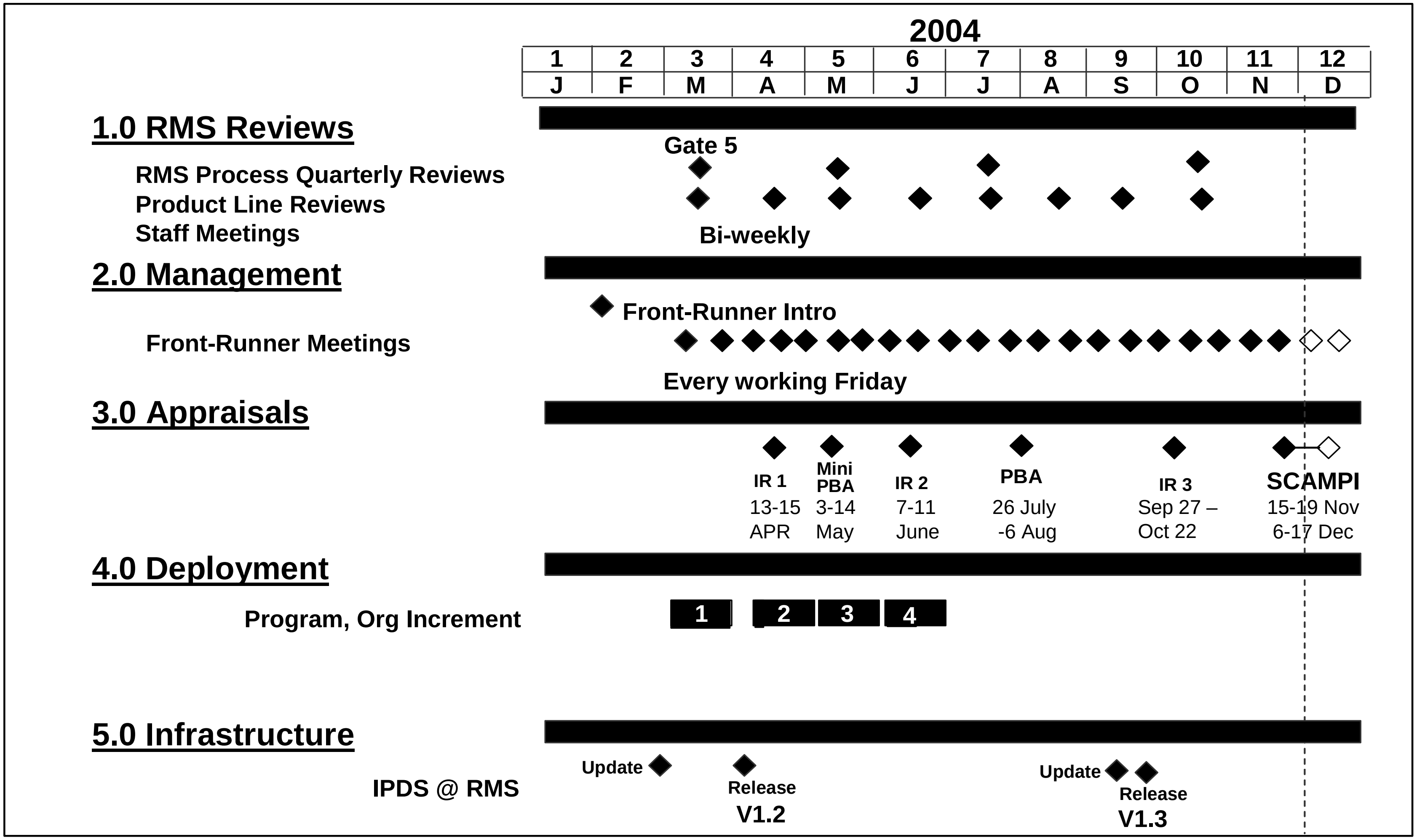

A very typical project master schedule

Just Doing An Activity Is Not Enough: Our Supporting Deployment Infrastructure

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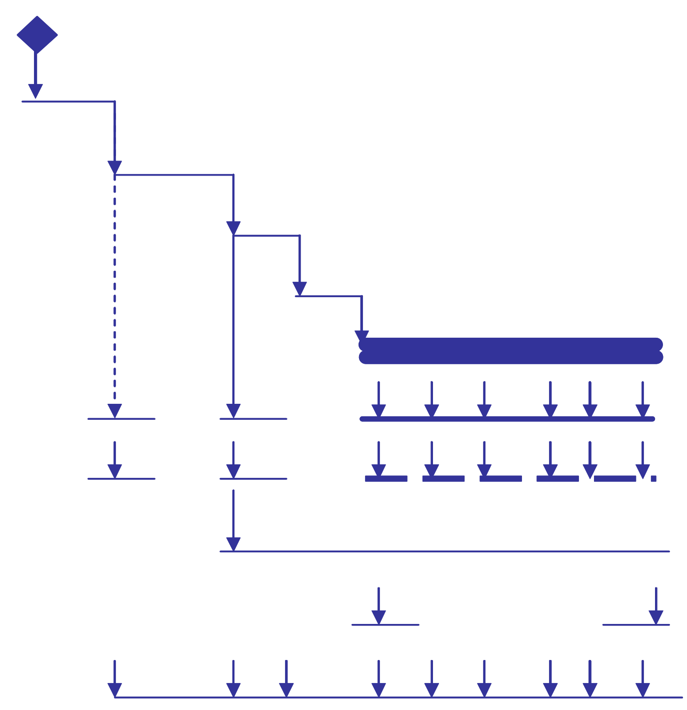
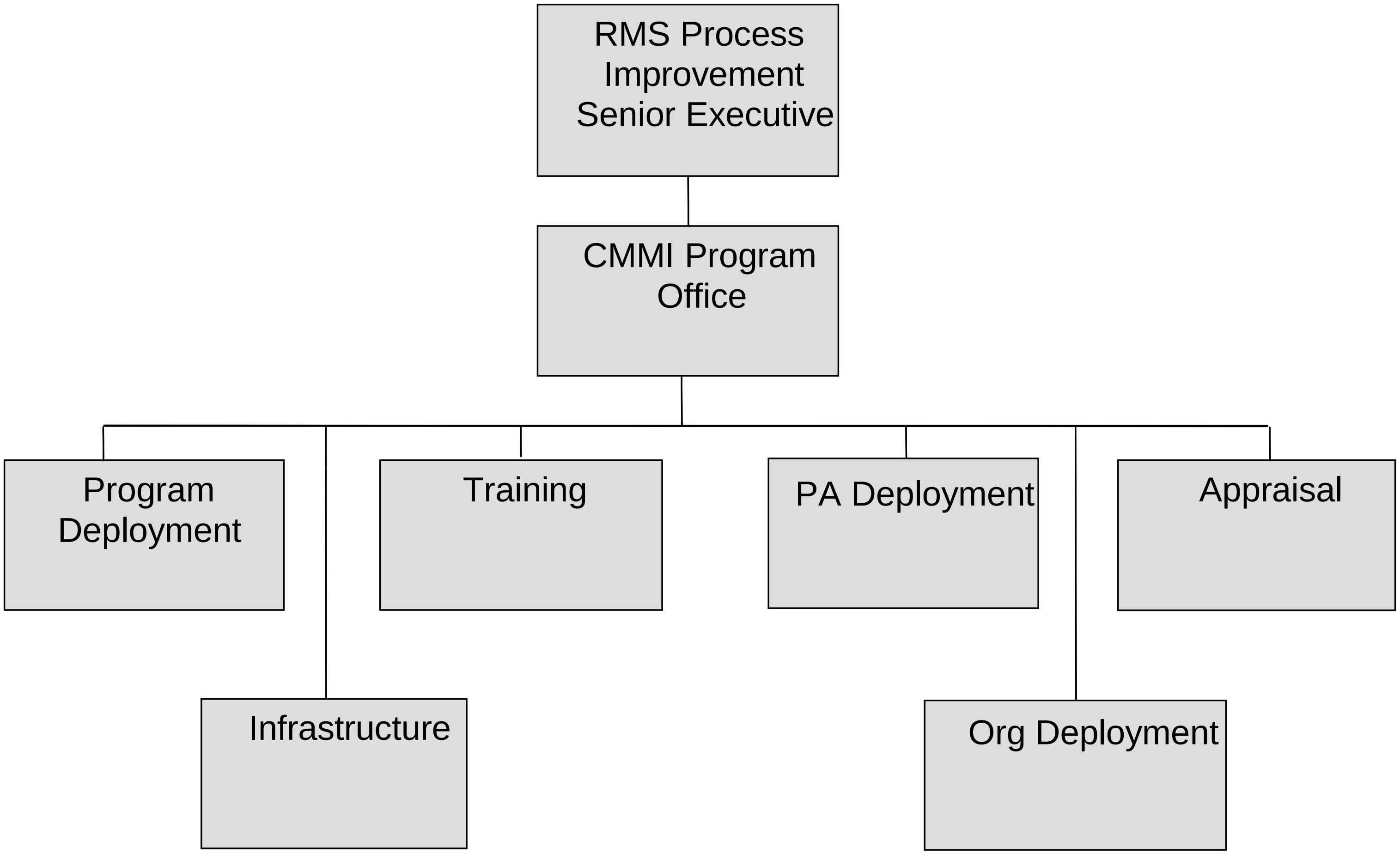
To Deploy a Process Instance		
Tasks	Reference	
	Process	GP
Input Process	Process X	3.1
Tailor	Process	3.1
Plan	Process	2.2 +
Resource	Process	2.3, 4
Train	Process	2.5
Execute	Process	3.1
QA/Peer Review	Process	2.9
CM	Process	2.6
Mon/Control	Process	2.8, 2.7
Review w/ Mgt	Process	2.10
Collect Artifacts	Process	3.2



Proper deployment is key to successfully changing the culture

The RMS CMMI Level 3 Project Team



And the CMMI Level 3 Project was one of the Process Action Teams (PATs) under the EPG

Training Strategy (An Extract)

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IPDS @ RMS Training Matrix	
Training Module	**Content**
Process Owner and Method Owner Reps	How Core Process, Core Support Process, Methods and Enablers Owners input new and updated content into IPDS @ RMS.
System Admin Training	Access control and application administration
Program Planning Team	IPDS @ RMS program startup (from initial WBS development through tailoring to IMP/IMS generation) based upon program attributes and business needs.
Senior Management	Business applicability of IPDS @ RMS; Senior management roles and responsibilities with respect to IPDS @ RMS.
IPDS @ RMS Overview	IPDS @ RMS development history and architecture; includes information about how the individual contributor navigates through and uses IPDS @ RMS.
IPDS @ RMS Tailoring Training	Tailoring goals, objectives, and methodology
EPG Roles & Responsibilities	How the organization defines, manages, deploys and improves IPDS @ RMS
Appraisal Training	Preparing for our CMMI assessment
Change Control Management	IPDS @ RMS CM responsibilities
IPDS @ RMS OE PPQA Training	Objective Evaluation for Process and Product Quality Practitioners
IPDS @ RMS CMMI Overview	Provides the background familiarization of CMMI, the language used, and how it affects IPDS @ RMS

Training modules were identified based upon IPDS @ RMS use cases across the RMS business

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EPG Training Matrix (An Extract)

Course Number [1]	Course Title	Course Hours	Enterprise Process Group (EPG) Roles								
			EPG Lead	EPG Chief Engineer	EPG IPT Leads	EPG Team Members	IPDS @ RMS CCB Members	Process Owner Reps	Method Owner Reps	Deployment Team Members	Process Area Experts (PAEs)
RMS-CMMI01	RMS CMMI Overview	2	R	R	R	R	R	R	R	R	R
KCSW0017	IPDS @ RMS Overview	2	R	R	R	R	R	R	R	R	R
KCSW0018	IPDS @ RMS Senior Management Training	2	R	S							
KCSW0042	IPDS @ RMS Program Planning Team Training	2	S	S	S			A	A	R	A
CMMICC02	IPDS @ RMS Change Control Training	1	R	R	R	R	R	R	R	R	R
KCSW0041	IPDS @ RMS EPG Roles & Responsibilities Training	2	R	R	R	R	S	R	R	S	S
QUAL2004	IPDS @ RMS OE PPQA Training (can be taken ILO QUAL2004)	4	S	S	S	S		S	S	S	S
QUAL2005	IPDS @ RMS OE PPQA Overview Training	2	R	R	R	R	S	R	R	R	R
CMMI201	Introduction to CMMI	24	R	R	R	S	S	S	S	S	R
SYS0017	Risk Management Overview for Chief Engineers and IPT/Section Leads	2	R	R	R						
JCMMI01	M&A and PMC Overview	2	R	R	R	R				A	R
KCSW0053	IPDS @ RMS Tailoring Overview	2	S	S	S	S		S	S	S	
KCSW0043	SAM Appraisal Training for Interviewees	1						S[4]	S[4]	S[4]	S[4]
KCSW0046	Organization Representative Appraisal Training for Interviewees	1	S[4]	S[4]	S[4]	S[4]	S[4]	S[4]	S[4]	S[4]	S[4]
KCSW0050	Senior Management Appraisal Training for Interviewees	1	S[4]					S[4]	S[4]	S[4]	S[4]
JAC1123	Project Metrics	8	R	R	R	R				A	R

LEGEND
R = Required Course
S = Suggested Course
A = As Appropriate (determined by individual and/or manager)

And, like programs, we identified specific project training by role

What We Learned: Key "Knowledge Gained"

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- **Plan for success (GP 2.2)**
  - **Leverage off of your already-defined best practices**
  - **Appraisal internal reviews**
  - **CMMI project reviews**
- **Keep the end in mind (GP 2.2)**
  - **Reverse planning**
- **Make the plan visible to the team (GP 2.2, GP 2.7)**
  - **CMMI project plan on the war room wall**
  - **Stakeholder meetings held where plan was visible**

"Critical Chain" methods, tools and techniques were extremely valuable enablers to our success

What We Learned:
Key “Knowledge Gained”

- **Manage to the plan (GP 2.8)**
  - **Daily stand up meetings focused on the critical chain**
- **Engage all levels of management (GP 2.4)**
  - **The role of our Program Director and Program Manager was primarily to remove barriers**
  - **Do not take the responsibility and accountability from those who are responsible and accountable**
- **Get the right team (GP 2.3, GP 2.4)**
  - **Identify key skills**
  - **Establish roles and responsibilities**
  - **Adequately resource a deployment support team**

What We Learned:
Key “Knowledge Gained”

- Ensure team members understand their roles, the program objectives, and commit to the plan (GP 2.7)
- Train the team (GP 2.5)
  - Model training
  - Appraisal training
  - IPDS @ RMS training
  - Roles and responsibilities training
- Review progress with senior management (GP 2.10)
  - Sponsor reviews
  - Center manager breakfasts
  - Program management lunches

What We Learned:
Key "Knowledge Gained"

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- **Identify and manage the work products (GP 2.6)**
  - Appraisal evidence
  - Plans
  - Presentation material
  - Intermediate work products
- **Make sure the process is effective (GP 2.9)**
  - Objectively evaluate the program plans and processes
  - Develop meaningful and effective management indicators and tracking tools
- **Identify / implement improvements (GP 3.2)**
  - Center manager breakfasts
  - Program manager lunches
  - Appraisal internal reviews
  - CRs to IPDS @ RMS, . . .

The Proof Of Our Planning: Completion on Schedule & Within Budget

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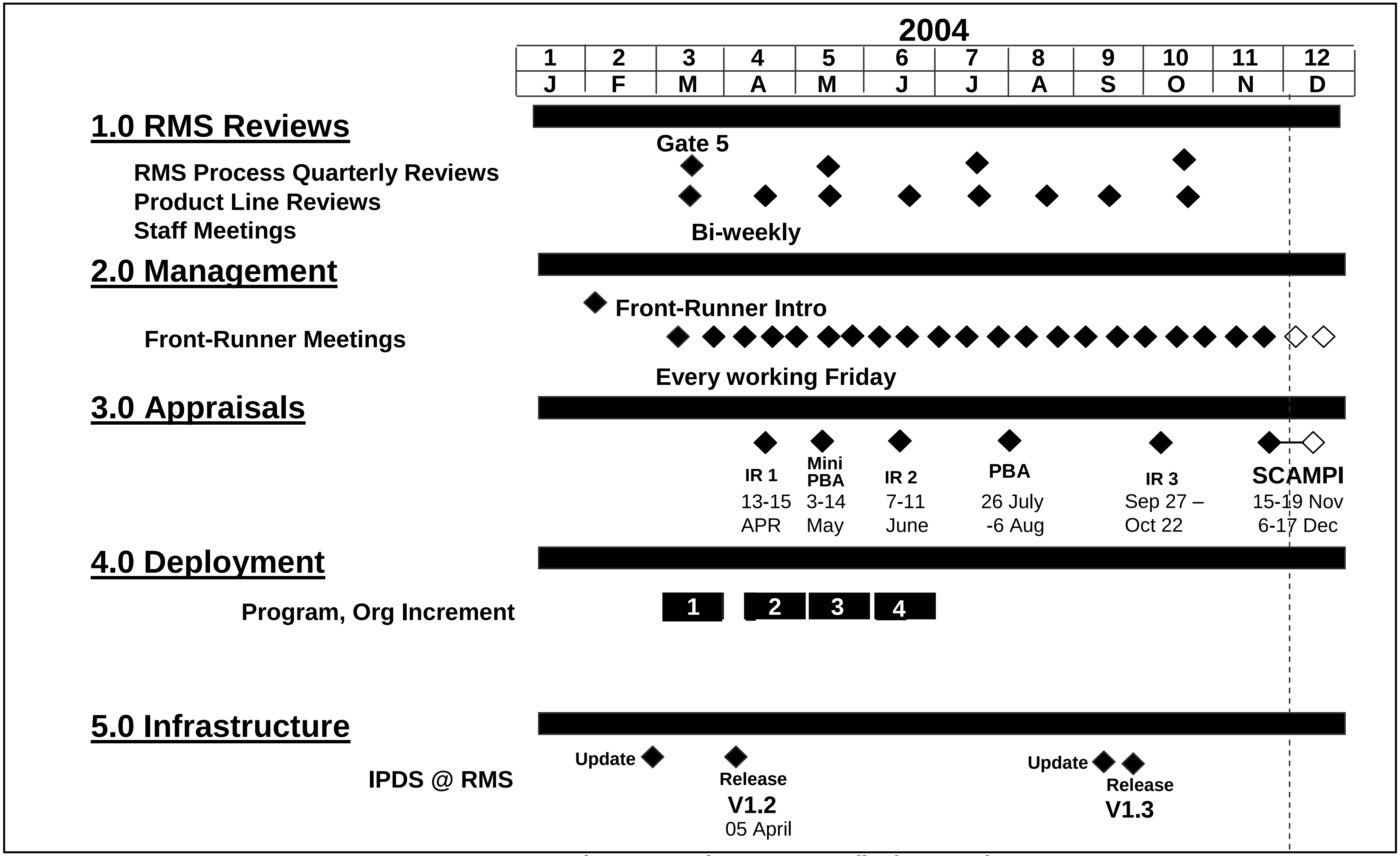

The Proof Of Our Planning: PBA Result (August 2004)

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	Maturity Level																	
	Level 2							Level 3										
Goals	REQM	PP	PMC	SAM	MA	PPQA	CM	RD	TS	PI	VER	VAL	OPF	OPD	OT	IMP	RSKM	DAR
GG3	B	B	B	D	B	D	D	C	C	C	C	C	B	B	C	C	C	E
GG2	C	C	C	C	B	B	C											
SG4																		
SG3		B					A	B	B	B	B						A	
SG2		B	B	C	D	B	A	B	C	D	D	B	C		B	A	A	
SG1	B	C	C	B	B	A	A	B	B	B	B	B	B	C	B	C	A	B

August 2004 Class B Appraisal – Progress on all fronts on par with our plan

The Proof Of Our Planning: Level 3 Success Chart (December 2004)

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Customer Success Is Our Mission

	Maturity Level																	
	Level 2							Level 3										
Goals	REQM	PP	PMC	SAM	MA	PPQA	CM	RD	TS	PI	VER	VAL	OPF	OPD	OT	IMP	RSKM	DAR
GG3	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
GG2	S	S	S	S	S	S	S											
SG4																		
SG3		S					S	S	S	S	S						S	
SG2		S	S	S	S	S	S	S	S	S	S	S	S		S	S	S	
SG1	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S

December 2004 SCAMPI – Success!

The Proof Of Our Planning: Other CMMI Level 3 Project Success Indicators

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- Raytheon Missile Systems is the single largest organization to achieve CMMI Level 3
- Schedule Performance Index – 1.0
- Cost Performance Index – 1.02
- Appraisal success indicators
  - Appraisal was not a discovery process
  - No late nights on the appraisal team
  - No weekend work
- Significant Findings: 0
- Weaknesses: 4
- Opportunities for Improvement: 3
- Strengths: 8

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Questions?

Thank you for your participation!

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Software Size Growth and Uncertainty:

Both Affect Estimate Accuracy

Presented by:
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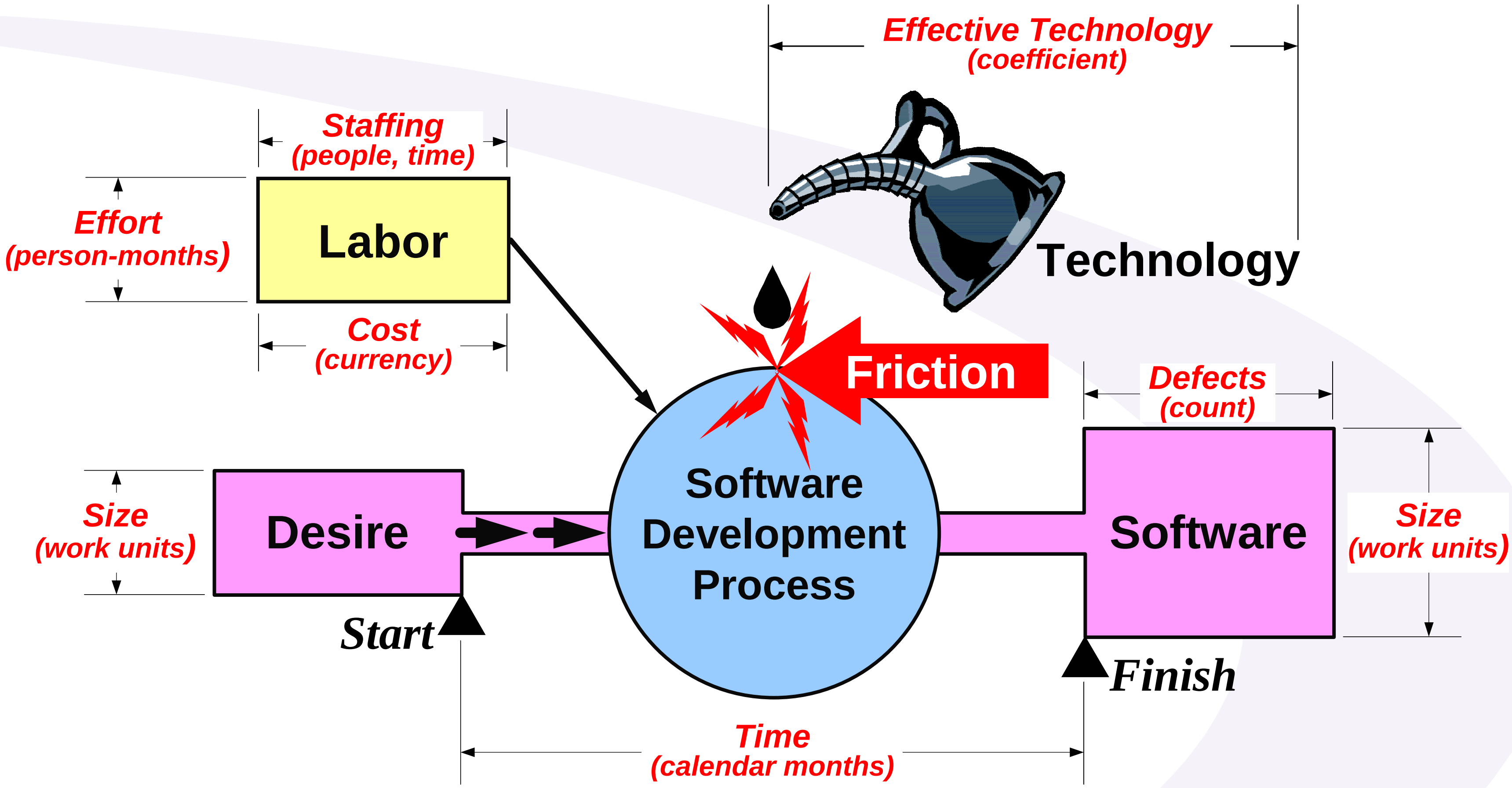
Summary

- **Measurement objectifies management**
- **Estimation is a function of progress (continuous process)**
- **A well-formed estimate is specified as a probability distribution**
- **Uncertainty 🡐**
  - Variability
  - Risk
  - Opportunity
- **Software size estimates 🡐**
  - Size growth
  - Size estimation variability

Software Development and Measurement



Fundamental Measures

Size

Effective Technology

Time

Effort → Cost, Staffing

Defects

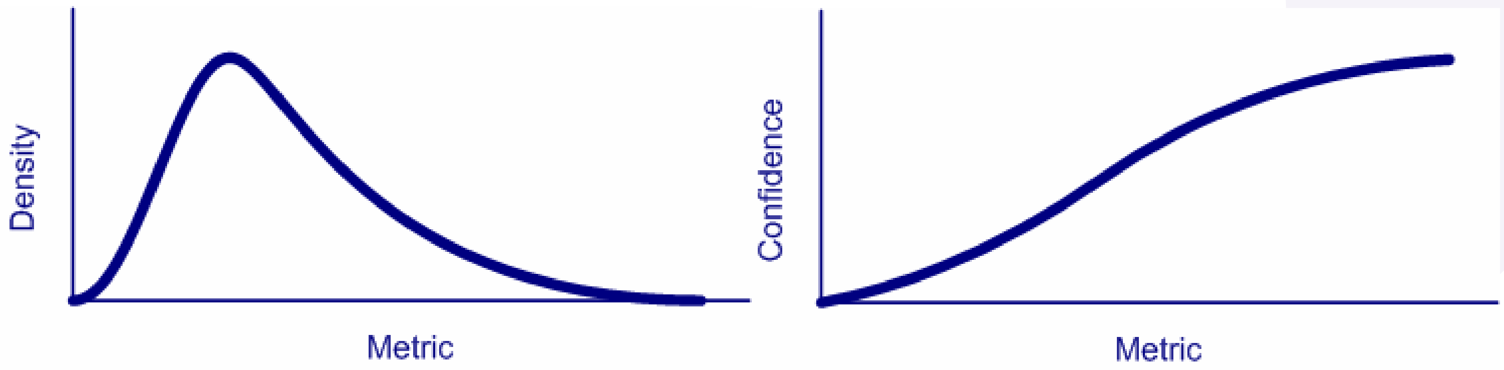
Estimate Defined

es·ti·mate (es′ti mit), *n.*

an approximate *judgment* or *calculation*, as of the value or amount of something

a prediction that is equally likely to be above or below the actual result (Tom DeMarco)

A WELL FORMED ESTIMATE IS A DISTRIBUTION



Two Key Drivers of Software Size Estimates

- **Size Growth**
  - Change in the baseline estimated software size due to:
    - – Change in development and/or operating environment
    - – Change in the required functionality
  - Technological and Programmatic risk
- **Size Estimation Variability**
  - Estimation process variability due to:
    - – Human behavior
    - – Model behavior

Size Growth

- **Operational Environment Volatility**
  - The mission changes.
  - The regulations that govern how this software should behave have changed.
- **Essence (Requirements) Volatility**
  - The customer doesn't know what he/she wants.
- **Essence Understanding (Requirements Completeness and Correctness)**
  - The customer doesn't understand the problem.
  - The specifications are vague.
- **Essence versus Implementation Correspondence**
  - The vendor adds a few extra features (gold plating).

Growth Factor Function

- **Yields Growth Factor as a function of normalized earned value**
- **Based on Galorath Incorporated analysis of historical data**
- **Embedded in *SEER-SEM*™'s Phase at Estimate parameter**

$$G(s) = -0.7s + 0.69$$

Growth Factor Function Distribution

- **Triangular Distribution per (Book 2002)**
- **Skew per modified (Tarbet 2002)**

$$\mathbf{G}(s) = \begin{bmatrix} L & M & H \end{bmatrix} = \begin{bmatrix} 0 & 0 & \mathrm{G}(s) \end{bmatrix}$$

Size Growth Impact Distribution

- **Function of normalized earned value (progress)**
- **Product of best guess size and growth factor**
- **Triangular Distribution per (Book 2002) from growth factor**
- **Skew per (Tarbet 2002) from growth factor**

$$\mathbf{S}_{\mathbf{G}}(s) = \mathrm{S}_{\mathrm{M}}(s)\mathbf{G}(s) = \begin{bmatrix} 0 & 0 & \mathrm{S}_{\mathrm{M}}(s)\mathrm{G}(s) \end{bmatrix}$$

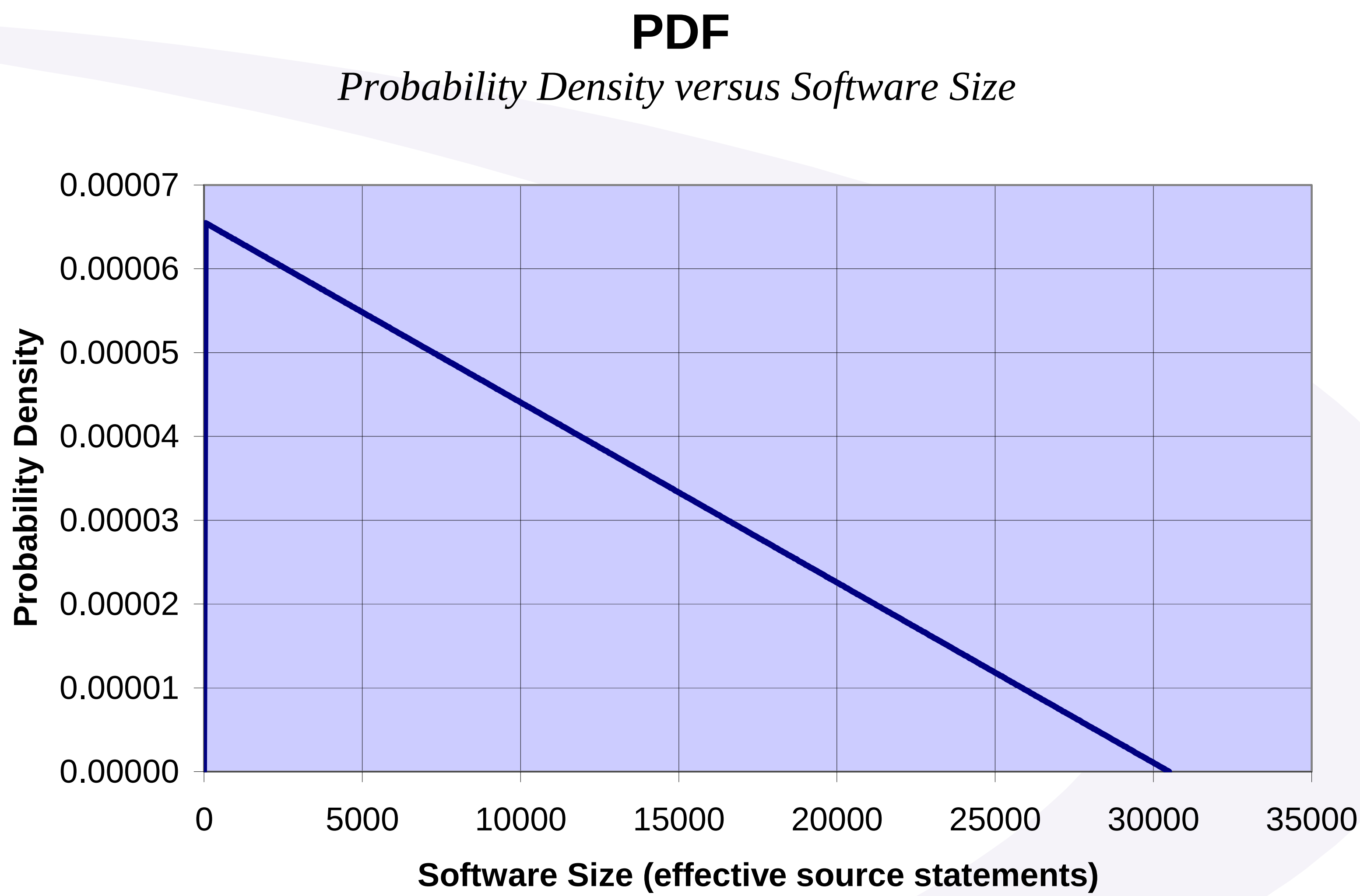
Size Growth
Example Calculation

- **Assume a best guess size at SRR of 50,000 ESLOC**
- **Assume normalized earned value of 11.8% at SRR**

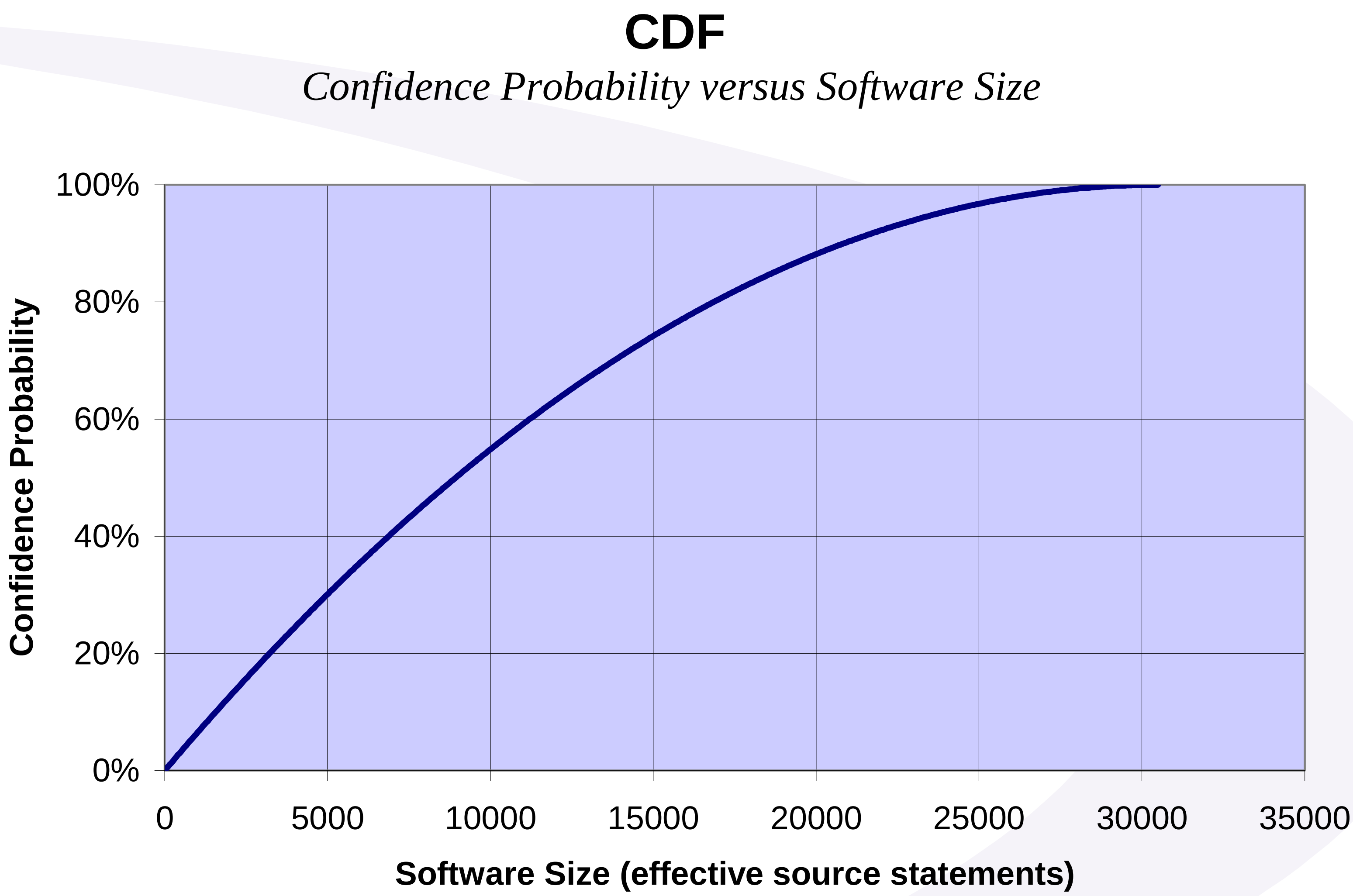
$$G_{SRR} = \mathrm{G}\left(11.8\%\right) = -0.7\left(11.8\%\right) + 0.69 = 0.61$$

$$\mathbf{S}_{\mathbf{G\_SRR}} = \left[\begin{matrix}0 & 0 & S_{M\_SRR}\left(0.61\right)\end{matrix}\right] = \left[\begin{matrix}0 & 0 & 30,500\end{matrix}\right]$$

Size Growth Example PDF



Size Growth Example CDF



Size Estimation Variability

- Uncertainty about the translation of essence to implementation
- Error and bias introduced by the estimation process
- Error and bias introduced by the estimation model / relationships
- Error and bias introduced by the people performing the process

Size Estimation Variability Impact Distribution

- **Function of normalized earned value (progress)**
- **Normal (Gaussian) Distribution per (Book 2002)**
- **Variance per (Tarbet 2002)**

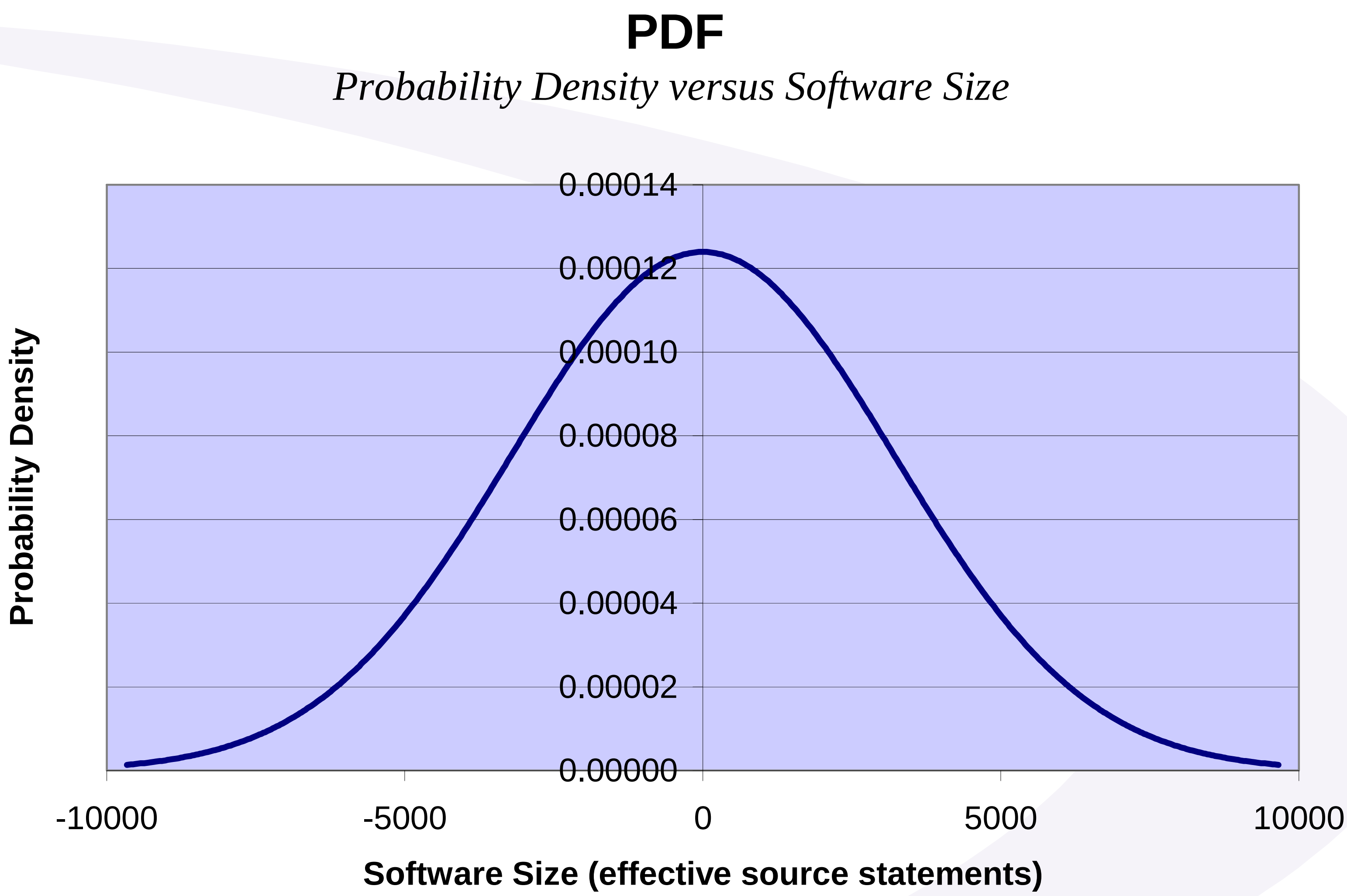
$$\mathbf{S_{EV}} = [\mu \quad \sigma] = \left[0 \quad \frac{(30\%)S_M}{(2)(2.33)}\right] = [0 \quad 3,219]$$

Size Estimation Variability Example Calculation

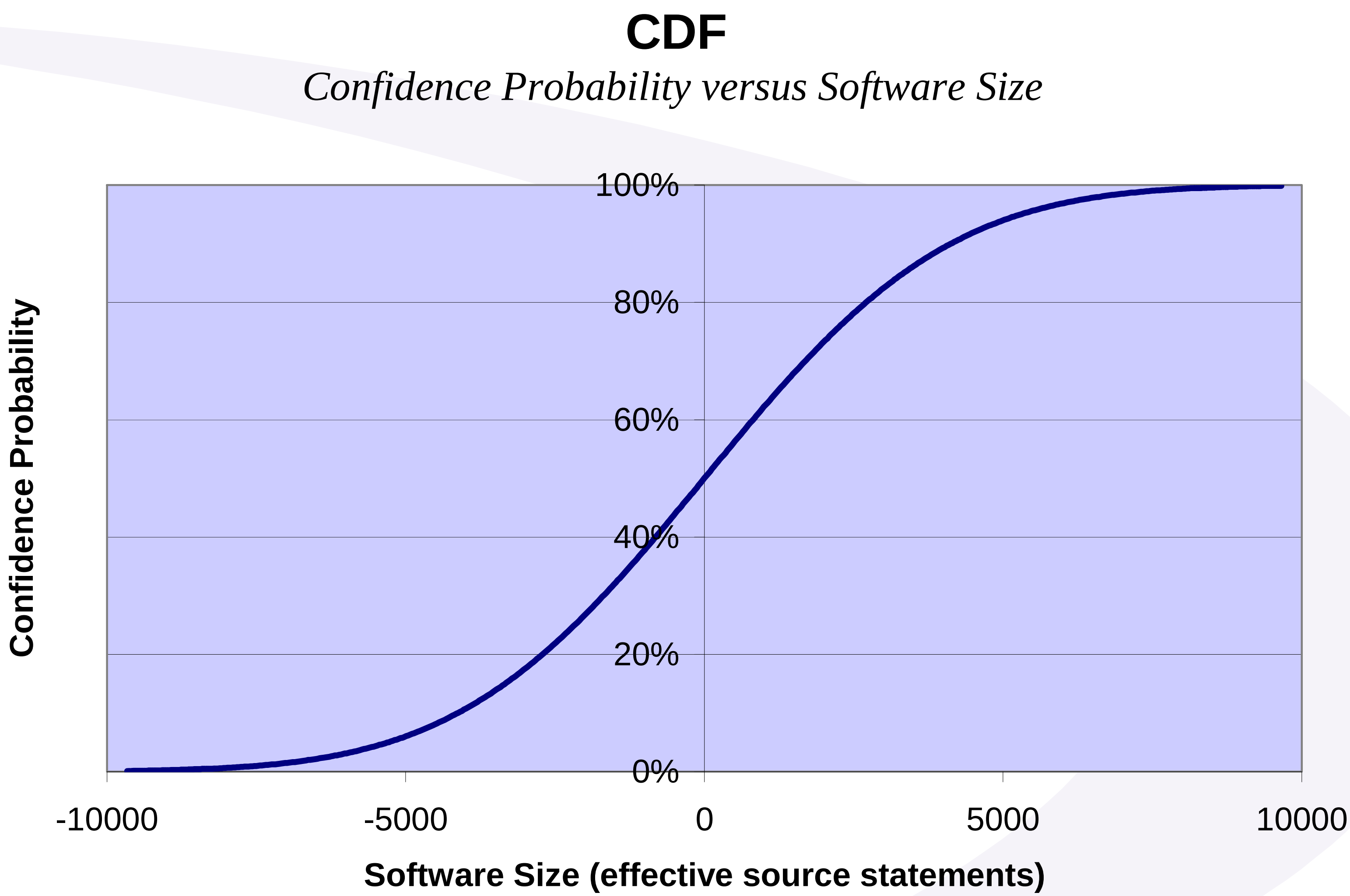
- **Assume a best guess size at SRR of 50,000 ESLOC**

$$\mathbf{S}_{\mathbf{EV\_SRR}} = \left[0 \quad \frac{(30\%)\, S_{M\_SRR}}{(2)(2.33)} \right] = [0 \quad 3{,}219]$$

Size Estimation Variability Example PDF



Size Estimation Example CDF



Combining Size Growth and Size (Estimate) Uncertainty

- **The mean of the sum of a set of random variables is equal to the sum of the means of each random variable in the set**
- **The standard deviation of the sum of a set of independent random variables is equal to the square root of the sum of the squares of the standard deviations of each random variable in the set**

$$\mathrm{E}\left(\sum_{i=1}^{n} X_i\right) = \sum_{i=1}^{n} \mathrm{E}\left(X_i\right)$$

$$\mathrm{V}\left(\sum_{i=1}^{n} X_i\right) = \sum_{i=1}^{n} \mathrm{V}\left(X_i\right)$$

Combining Size Growth and Size (Estimate) Uncertainty

- **Sum of the means:**

$$\mu_{S_M(s)} = S_M(s)$$

$$\mu_{\mathbf{S_G}(s)} = \frac{0 + 0 + S_M(s)G(s)}{3} = \frac{S_M(s)G(s)}{3}$$

$$\mu_{\mathbf{S_{EV}}(s)} = 0$$

$$\therefore \mu_{\mathbf{S}(s)} = S_M(s) + \frac{S_M(s)G(s)}{3} = \frac{S_M(s)\left(G(s)+3\right)}{3}$$

Combining Size Growth and Size (Estimate) Uncertainty

- **Square root of the sum of the squares of the standard deviations:**

$$\sigma_{S_M(s)} = 0$$

$$\sigma_{S_G(s)} = \sqrt{\frac{L^2 + M^2 + H^2 - LH - LM - MH}{18}} = \sqrt{\frac{\left(S_M(s)G(s)\right)^2}{18}}$$

$$\sigma_{S_{EV}(s)} = \frac{(30\%)S_M(s)}{(2)(2.33)}$$

$$\therefore \sigma_{S(s)} = \sqrt{\frac{\left(S_M(s)G(s)\right)^2}{18} + \left(\frac{(30\%)S_M(s)}{(2)(2.33)}\right)^2}$$

Example Calculation

- **Assume a best guess size at SRR of 50,000 ESLOC**
- **Assume a growth factor at SRR of 0.61**

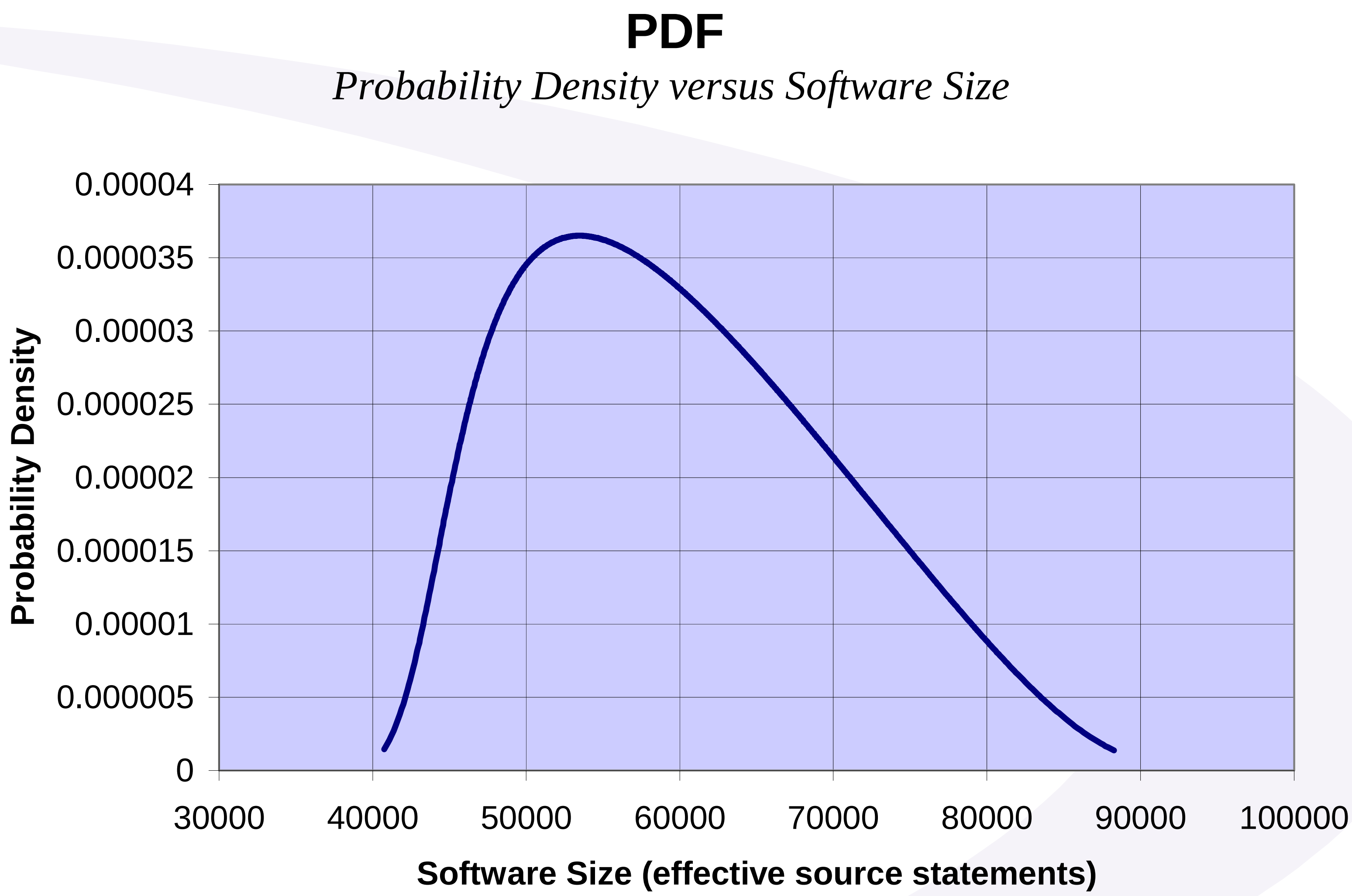
$$\mathbf{S}_{\mathbf{SRR}} = \begin{bmatrix} \mu & \sigma \end{bmatrix}$$

$$\mathbf{S}_{\mathbf{SRR}} = \left[\frac{S_{M\_SRR}\left(G_{SRR}+3\right)}{3} \quad \sqrt{\frac{\left(S_{M\_SRR}G_{SRR}\right)^2}{18} + \left(\frac{(30\%)S_{M\_SRR}}{(2)(2.33)}\right)^2} \right]$$

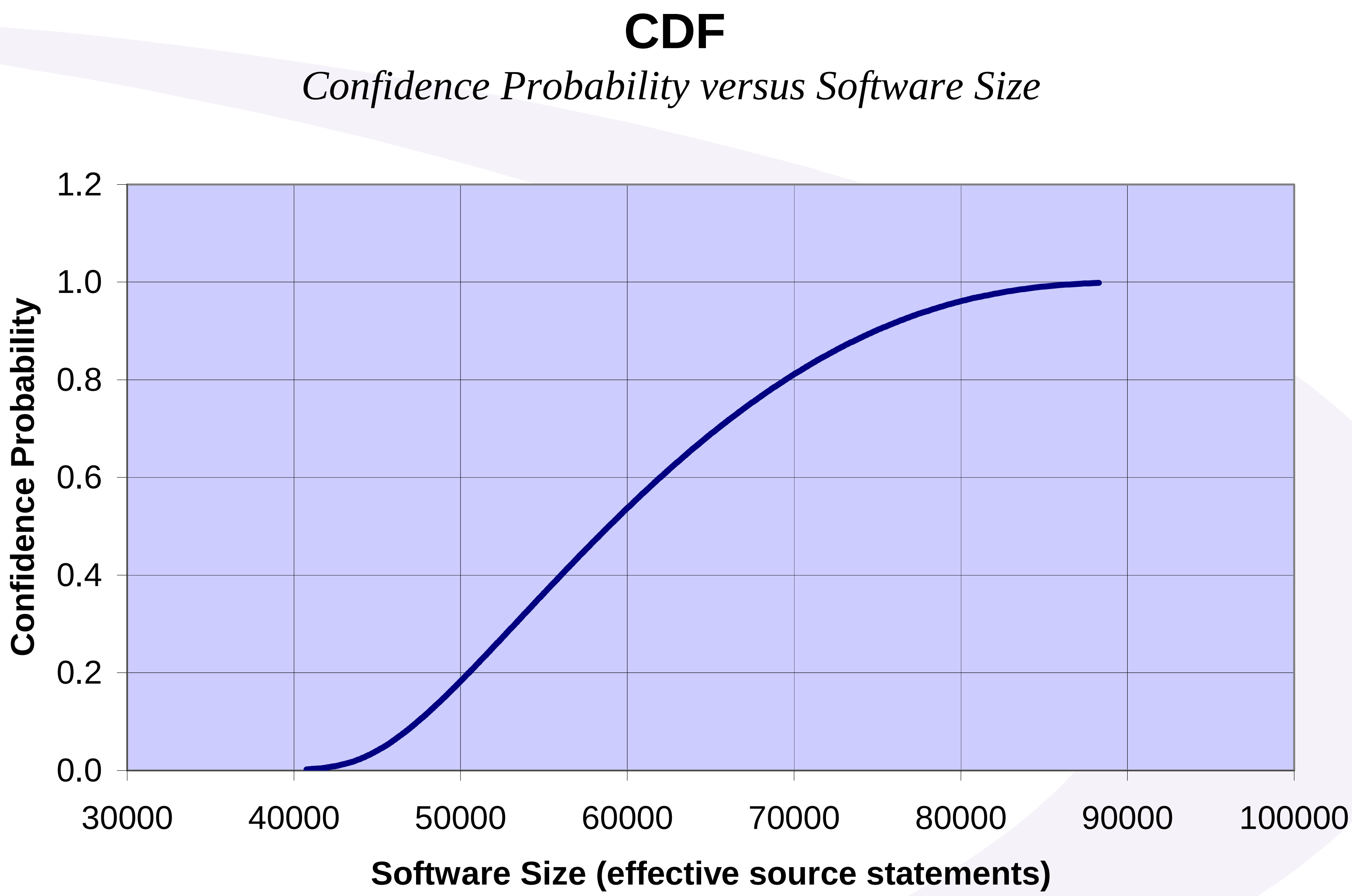
$$\mathbf{S}_{\mathbf{SRR}} = \left[\frac{50,000\left(0.61+3\right)}{3} \quad \sqrt{\frac{\left((50,000)(0.61)\right)^2}{18} + \left(\frac{(30\%)(50,000)}{(2)(2.33)}\right)^2} \right]$$

$$\therefore \mathbf{S}_{\mathbf{SRR}} = \begin{bmatrix} 60,167 & 7,877 \end{bmatrix}$$

Combined PDF



Combined CDF



Review

- **Measurement objectifies management**
- **Estimation is a function of progress (continuous process)**
- **A well-formed estimate is specified as a probability distribution**
- **Uncertainty ←**
  - Variability
  - Risk
  - Opportunity
- **Software size estimates ←**
  - Size growth
  - Size estimation variability

Software Size Growth and Uncertainty

Both Affect Estimate Quality and Project Risk

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Abstract. Examination of currently-accepted software cost, schedule, and defect estimation algorithms reveals a common acknowledgment that estimated software size is the single most influential independent variable. Unfortunately, *"The most important business decisions about a software project are made at the time of minimum knowledge and maximum uncertainty."* This includes minimum knowledge and maximum uncertainty about a software product's effective size at the time when most estimating is done. Further complicating the issue of estimate quality, in the author's opinion, is the lack of a commonly-accepted taxonomy. This paper proposes definitions for and the relationship between two key attributes of software size estimates: ***growth*** and ***estimation process variability***, both being distributions, the dispersions of which decrease as a function of project progress.

Introduction

Purpose

This paper proposes definitions for and the relationship between two key attributes of software size estimates: ***growth*** and ***estimation process variability***, both being distributions, the dispersions of which decrease as a function of project progress.

Scope

This paper focuses on handling size growth and variability with cost and schedule estimation methods that employ parametric estimating techniques; however, in the author's opinion, these ideas could readily be extended to include any cost and schedule estimation method. The issues, assumptions, and propositions presented in this paper apply to all software development projects regardless of application domain or Software Development Life Cycle (SDLC) paradigm.

Background

Examination of currently-accepted software cost, schedule, and defect estimation algorithms reveals a common acknowledgment that ***assumed software size*** is the single most influential independent variable. It follows then that assumed software size has a significant impact on a given estimate's quality or usefulness. Unfortunately, *"The most important business decisions about a software project are made at the time of minimum knowledge and maximum uncertainty."*[5] This includes minimum knowledge and maximum uncertainty about a software product's effective size at the time when most estimating is done [5]. Further complicating the issue of estimate quality, in the author's opinion, is the lack of a commonly-accepted taxonomy.

Relevant Taxonomy and Context

Software Development Taxonomy

Terms defined:[1]

- ***Abstraction –*** A representation of an idea or concept expressed in a particular medium or language.
- ***Desire –*** A want or need.

[1] Term definitions extracted from [5].

- ***[Software] Requirements –*** An abstraction of a desire for which computer technology is thought to be a viable solution; the ***essence*** of a software product.
- ***Software –*** An abstraction of a desire expressed as instructions and data in a form that can be acted upon by a computer.
- ***Process –*** A set of actions or operations conducing to an end [4].
- ***Software Development Process –*** A generalized set of related activities that transform desires into software.
- ***Software [Development] Project –*** A specific instance of a software development process.
- ***Software Product –*** The primary (deliverable) result of a Software Development Project; the ***implementation*** of a software product.

Software Development Process Context

Figure 1 depicts the context of a software development process; i.e., how it interfaces with its environment. All instances of software development processes seek to transform software requirements into a software product. To accomplish this transformation, they consume energy in the form of labor (people doing work) from project initiation to project completion. Since no software development process is a *perfect machine*, it produces some amount of waste or entropy (undesired byproducts).

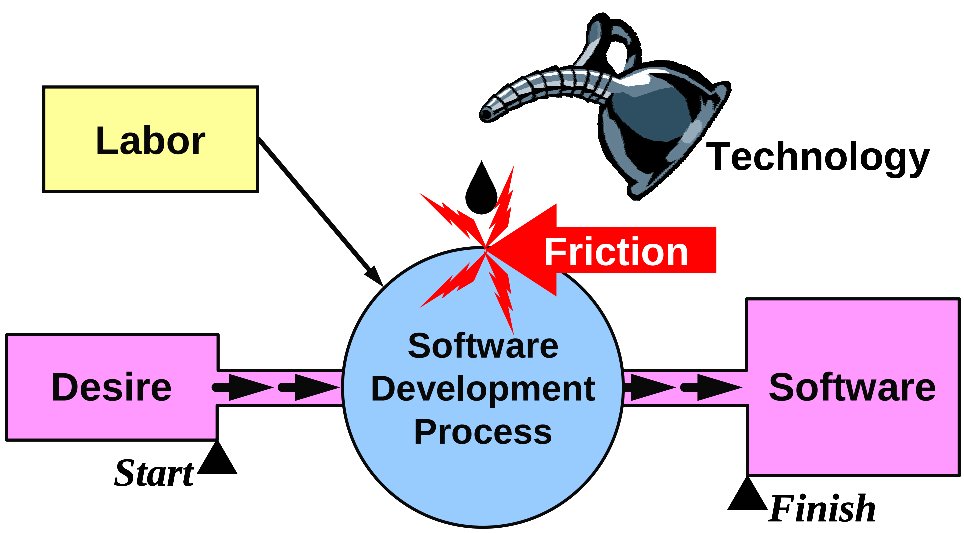

Figure 1: Software Development Context[2]

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Measuring the Software Development Process

The key to effectively and efficiently measuring the software development process is to pick measures that quantify the process's connections to its surrounding environment. Just about any core set of software development process measures will include the following:

- ***Size –*** An abstraction's mass, inertia, bigness (as it directly relates to the work that must be done).
- ***Duration –*** The elapsed calendar time between process initiation and process completion.
- ***Effort ➔ Cost, Staffing –*** People doing work during the software development process and their associated cost, over elapsed calendar time.
- ***Quality –*** Defect discovery and removal over elapsed calendar time.

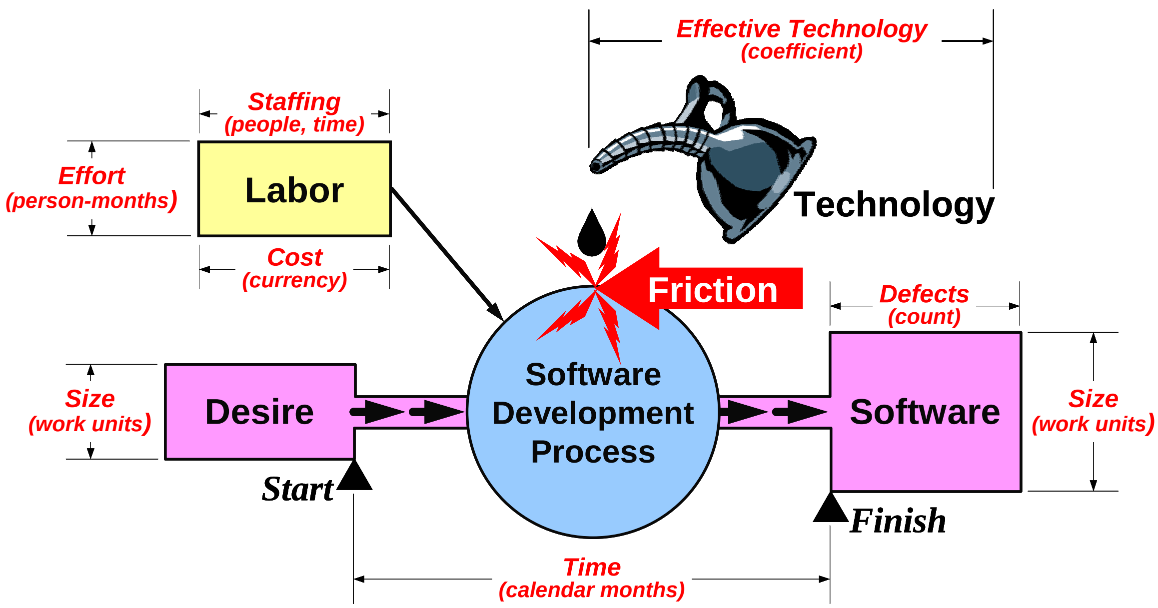

Figure 2: Software Development Process Context with Measurement[3]

A strong indication of the usefulness of these measures is the fact that they address the most frequently asked questions about software development projects:

- *How big will the product be when delivered?*
- *How long is it going to take?*
- *How many people will be needed and when?*

[3] Figure reprinted with permission from Michael A. ROSS Consulting & Training. All rights reserved.

- *How much will it cost?*
- *How reliable will the product be when delivered?*

Attributes of Estimated Software Size

Best Guess Size Estimate Defined

People generally think of software size as a count of the number of lines of code or the number of function points that will eventually be contained by a to-be-developed software product; this count representing some sort of *best guess* S_M. Natural and relevant questions should include, *"What considerations are included, what considerations are omitted, how confident are we in this best guess, how much uncertainty surrounds this best guess, and how might this best guess change over elapsed calendar time during the software development project?"*

First of all, since we are concerned about how this *best guess* might change over elapsed calendar time we change our best guess representation to be a function of progress $S_M(s)$ where progress s in this context is defined to be ***normalized earned value***; i.e., the project starts at $s = 0\%$ complete and finishes at $s = 100\%$ complete [6].

Second, the mention above of confidence and uncertainty and the use of the term *best guess* implies something that has a stochastic nature; i.e., there exists a set (a distribution) of numerous possible outcomes, our best guess being but one element of this distribution. We therefore postulate that a well-formed ***estimate*** is specified in terms of a selected probability distribution and its attributes. It seems reasonable then to assume that our ***best guess*** represents some sort of central tendency of its associated distribution. It also seems reasonable to assume that this distribution is continuous rather than discrete.[4] The next set of questions are, *"What kind of distribution are we talking about (Uniform, Normal, Beta, Triangular, etc.) , what are its attributes (location, dispersion, number of modes, skewness, kurtosis, etc.), and which form of central tendency does this* best guess *represent (mean, median, mode, other)?"*

Distribution Functions

There has been and continues to be much debate over which distribution function best represents estimated software size uncertainty. The leading candidates for this honor are (in no particular order):[5]

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[4] The author acknowledges that software size, being a count of something, could be viewed as discrete rather than as continuous; however, since the range of possible outcomes is relatively large and the resolution of possible outcomes is relatively fine, the author chooses to view the distribution as continuous.

[5] Equations for these distributions and their attributes can be found at http://www.mathworld.wolfram.com.

- Normal (Gaussian) Distribution
- Bi-Normal Distribution[6]
- Triangular Distribution
- Beta (special case of a Weibull) Distribution

Location (Central Tendency)

We have already suggested that a *best guess* represents some sort of central tendency of its associated uncertainty distribution. Intuitively, of the three most common measures of central tendency (mean, median, and mode), it is the mode that seems to best represent the idea of a best guess. For example, I might say something like, "If I were to run this project many times (approaching infinity), I believe, based on what I know today, that a final size outcome of about 50,000 effective source statements would happen more times than any other final size outcome. In other words, approximately 50,000 effective source statements is thought to be the ***most likely*** or mode value of our size uncertainty distribution. It follows then that ***best guess*** and ***most likely*** are synonymous within the context of this discussion. Mathematically, this value is the global maximum of our size uncertainty distribution's Probability Density Function (PDF).

Dispersion

Of the three most common measures of dispersion; mean deviation, interquartile range, and standard deviation σ; the latter is almost invariably used by statisticians [2]. It is defined as the square root of the second central moment m_2 (variance) which, in turn, is defined as the average of the squared deviations from the mean.

Modes, Skewness and Kurtosis

We make the simplifying assumption that the distributions representing element-level contributors to uncertainty are unimodal; however, combinations of multiple distributions can yield multimodal distributions.

Skewness (asymmetry to the left or right) and kurtosis (peakedness) are measured as functions of the third and fourth central moments m_3 and m_4 respectively. Skewness is presented here since most estimators agree that size uncertainty distributions are asymmetric and tend to be right skewed (long tail on the right side of the PDF). Kurtosis does not seem to be too much of an issue at this point; however, as more data is

[6] Combines the left half of one Normal Distribution's PDF having a standard deviation σ_{Low} with the right half of another Normal Distribution's PDF having a standard deviation σ_{High} in order to model skewness using Normal Distribution math.

collected that can be used to relate size estimates with size outcomes, it may become more relevant to describing the ideal size uncertainty distribution.

Uncertainty Defined

We now introduce an emerging model that defines the notion of uncertainty as a function of variability, risk, and opportunity [3] and use the following conceptual model as a guide for describing size uncertainty[7].

$$U = \Sigma V + \left(\Sigma R - \Sigma O\right) \qquad \textbf{Eqn. 1}$$

where:

- U — Uncertainty: a random variable representing the uncertainty about a particular value or metric, expressed as a probability distribution of possible outcomes.
- V — Variability: a random variable representing the impact on the particular value or metric by an event or events that *will* occur (probability of 1), expressed as a probability distribution of possible outcomes.
- R — Risk: a random variable representing the impact on the particular value or metric by a specific *unfavorable* event that may or may not occur (there exists some known probability of occurrence).
- O — Opportunity: a random variable representing the impact on the particular value or metric by a specific *favorable* event that may or may not occur (there exists some known probability of occurrence).

Two Key Drivers of Software Size Estimates

Within the software estimation community and its serviced stakeholder organizations, there has, for better or worse, evolved two sometimes complementary and sometimes conflicting terms: ***size growth*** and ***size uncertainty***. We propose the following definitions for these two terms in the hope that some of the inherent conflict can be understood and minimized.

- ***Size Growth –*** *Variability* in the *baseline* estimated software size that results from a change in the common understanding of the required functionality and/or the context in which the software development project and its resultant software product exist. Note that we do not characterize size growth as a *risk* in our

[7] Use of the summation symbols in the conceptual relationship is intended to show aggregation of multiple contributing random variables, each of which may be multivariate in nature. The summation symbols do not imply that simple arithmetic addition is appropriate; it is more likely that simulation techniques such as Monte Carlo will be required to properly evaluate the contributors to uncertainty.

model. We assume that size growth *will* occur and that it embodies the impact of those events not yet known and specified (not yet characterized as risks/opportunities). Note also that we have narrowed the focus of the term size growth to one of a technological and programmatic nature. This definition implies the desirability to find some sort of growth factor function that can predict additional size and its associated uncertainty. As the project matures, we expect that risks and opportunities will become known and specified and, therefore, removed from consideration as a part of variability. This implies a desire to express growth factor as a function of progress on a given project.

- ***Size (Estimation) Uncertainty –*** *Variability* that results from the stochastic nature of human behavior and model behavior associated with the software size estimation process. Note that we have narrowed the focus of the term size uncertainty (hereinafter referred to as ***size estimation variability***) to one of process rather than to one that could be assumed to encompass all estimated size uncertainty; i.e., size growth and size estimation variability are mutually exclusive. Size estimation variability is described by a specific distribution (including its attributes) of possible software size impacts given some common understanding of the required functionality and of the context in which the software development project and its resultant software product exist.

Size Growth

Software project management would be a whole lot simpler if we knew, from the beginning, precisely how big the software will end up being. Issues of efficiency would then be the sole source of cost and schedule uncertainty. Unfortunately, static software size is not reality. A rare project experiences no requirements changes and no expansion of scope. This is a serious issue since variations in software size have the single largest influence on software development time, effort, cost, staffing, and the number of delivered defects [5].

We have previously stated that size growth stems from context volatility. In order to understand these notions of size growth and context volatility we must understand its source. If one were to solicit a list of things that cause software size to grow it might include some of the following:

- The customer doesn’t know what he/she wants.
- The customer doesn’t understand the problem.
- The mission has changed.
- The regulations that govern how this software should behave have changed.
- The vendor added a few extra features that he/she thought the customer would like.

- The vendor finished early so the customer and/or the vendor thought up a few things to add.

Analysis of the preceding list suggests the following possible organization of issues that influence software size growth:

- Operational Environment Volatility
- Essence (Requirements) Volatility
- Essence Understanding (Requirements Completeness and Correctness)
- Essence versus Implementation Correspondence

All of the preceding issues seem to fall into either the Technical or the Programmatic Risk[8] Driver categories per [1].

We earlier suggested the desire for a growth factor function that can predict additional size as a function of progress on a given project. Analysis of historical data collected by Galorath Incorporated suggests that this growth factor function $\mathrm{G}(s)$ is linear and is approximately:

$$\mathrm{G}(s) = -0.7s + 0.69 \qquad \textbf{Eqn. 2}$$

For example, if we assume that a project's normalized earned value when Software Requirements Analysis is complete (at Software Requirements Review or SRR) to be 11.8%, then[9]:

$$G_{SRR} = \mathrm{G}(11.8\%) = -0.7(11.8\%) + 0.69 = 0.61 \qquad \textbf{Eqn. 3}$$

Since we have already judged the issues impacting size growth to be technical or programmatic in nature, we assume that our size growth factor distribution can best be represented as a Triangular Distribution per [1] described by the parameter vector $\mathbf{G}(s)$:

$$\mathbf{G}(s) = [L \quad M \quad H] = [0 \quad 0 \quad \mathrm{G}(s)] \qquad \textbf{Eqn. 4}$$

where L is the lowest conceivable growth factor value, M is the most likely (mode) growth factor value, and H is the highest conceivable growth factor value [7][10]. If our

[8] Note that this usage of the term Risk is not consistent with our uncertainty model but, rather, refers to terminology used in the cited document.

[9] Note that this example is consistent with the results documented in [7].

[10] The results of [7] suggest $0 = L < M < H$. To preserve consistency with our system of distributions we have transformed the results in [7] to force $M = L = 0$ while maintaining the total area under the Triangular Distribution PDF.

best guess of software size at SRR $S_{M\_SRR} = 50,000$ effective source statements (based on the current common understanding when Software Requirements Analysis is complete of the required functionality and of the current common understanding of the technology to be applied), then the size growth implication distribution is a Triangular Distribution described by the parameter vector $\mathbf{S_G}(s)$:

$$\mathbf{S_G}(s) = \mathrm{S_M}(s)\mathbf{G}(s) = \begin{bmatrix} 0 & 0 & \mathrm{S_M}(s)\mathrm{G}(s) \end{bmatrix} \qquad \textbf{Eqn. 5}$$

$$\mathbf{S_{G\_SRR}} = \begin{bmatrix} 0 & 0 & S_{M\_SRR}(0.61) \end{bmatrix} = \begin{bmatrix} 0 & 0 & 30,500 \end{bmatrix}$$

The Probability Density Function (PDF) for a Triangular Distribution is given by:

$$\mathrm{P_{Triangular}}(x) = \begin{cases} \dfrac{2(x-L)^2}{(H-L)(M-L)} & \text{for } \mathrm{x} \in [L, M] \\ 1 - \dfrac{2(H-x)^2}{(H-L)(H-M)} & \text{for } \mathrm{x} \in [M, H] \end{cases} \qquad \textbf{Eqn. 6}$$

The Cumulative Distribution Function (CDF) for a Triangular Distribution is given by:

$$\mathrm{D_{Triangular}}(x) = \begin{cases} \dfrac{(x-L)^2}{(H-L)(M-L)} & \text{for } \mathrm{x} \in [L, M] \\ 1 - \dfrac{(H-x)^2}{(H-L)(H-M)} & \text{for } \mathrm{x} \in [M, H] \end{cases} \qquad \textbf{Eqn. 7}$$

The Probability Density Function (PDF) and the Cumulative Distribution Function (CDF) for the Triangular Distribution described by $\mathbf{S_G}(s)$ are graphed below in Figure 3 and Figure 4 respectively.

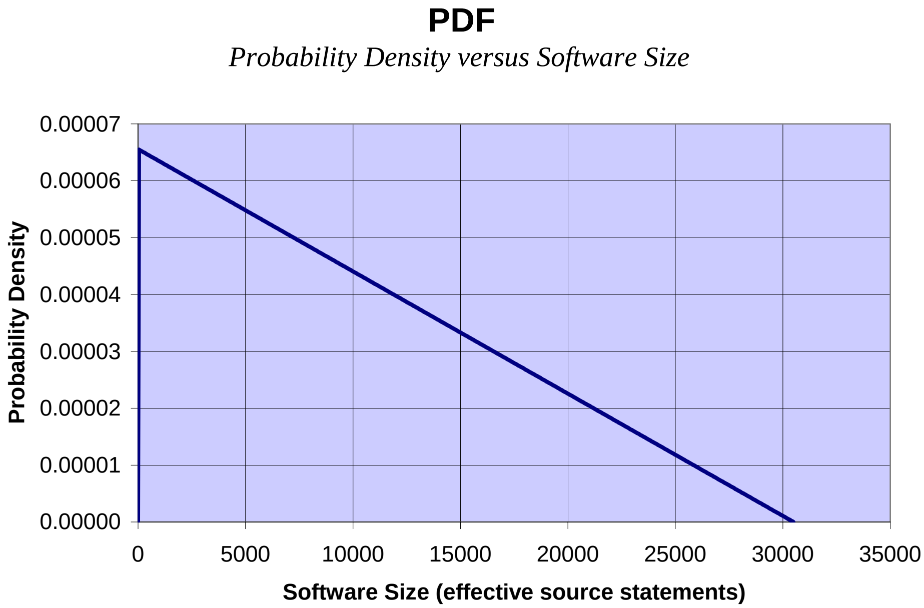

Figure 3: PDF of a Triangular Distribution Described by $S_G(s)$

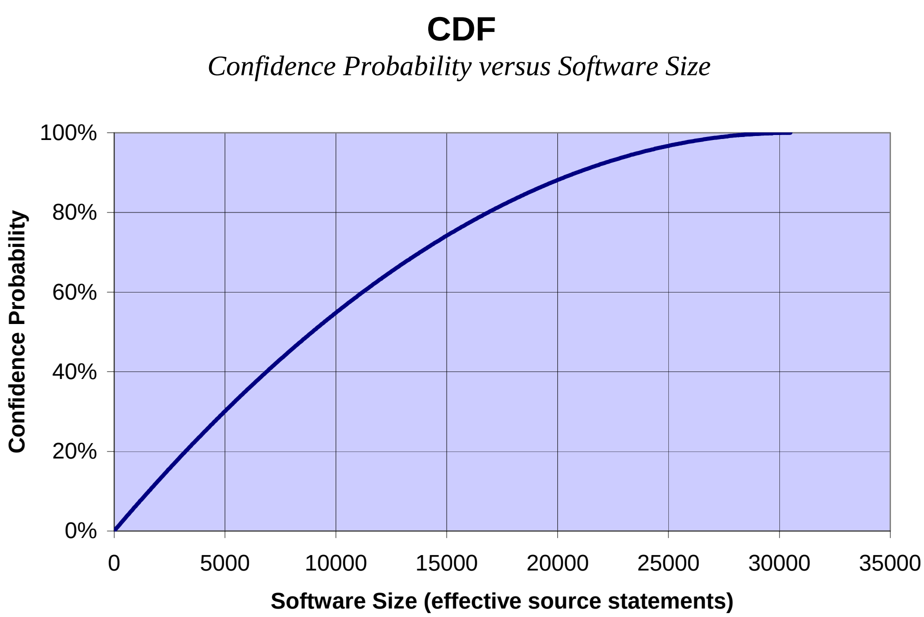

Figure 4: CDF of a Triangular Distribution Described by $S_G(s)$

Size Estimation Variability

Because, until project completion, software size must be estimated, it follows that software size is uncertain, regardless of whether or not we recognize size growth. The very nature of the word *estimate* implies uncertainty. We assume uncertainty in this context to mean that there exists some distribution (with specific attributes) of possible software size outcomes. Therefore, in order to quantify size estimation variability we must define this distribution and its attributes. Size estimation process and model variability are best represented by a Normal (Gaussian) Distribution [1]. We assume, based on [7], a $(\pm 30\%)\mathrm{S_M}(s)$ conceivable range of this distribution; conceivable being defined as $\pm 2.33\sigma$ (between the 1st to the 99th percentiles).

Continuing our example situation, if our best guess of software size at SRR is $S_{M\_SRR} = 50,000$ effective source statements (based on the current common understanding when Software Requirements Analysis is complete of the required functionality and of the current common understanding of the technology to be applied), then the amount of additional estimated software size due to size estimation variability is a Normal Distribution described by the parameter vector $\mathbf{S_{EV}}(s)$:

$$\mathbf{S_{EV}}(s) = [\mu \quad \sigma] = \left[0 \quad \frac{(30\%)\mathrm{S_M}(s)}{(2)(2.33)} \right] \qquad \text{Eqn. 8}$$

$$\mathbf{S_{EV}} = \left[0 \quad \frac{(30\%)S_{M\_SRR}}{(2)(2.33)} \right] = [0 \quad 3,219]$$

where μ is the arithmetic mean of the distribution (in effective source statements) and σ is the standard deviation of the distribution (also in effective source statements). Note that we specify μ to be 0 in order to center the distribution about 0, the left half (negative) representing size decrease due to estimation variability, the right half (positive) representing size increase due to estimation variability.

The Probability Density Function (PDF) for a Normal (Gaussian) distribution is given by:

$$\mathrm{P_{Normal}}(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{\frac{-(x-\mu)^2}{2\sigma^2}} \quad \text{for } x \in (-\infty, \infty) \qquad \text{Eqn. 9}$$

There exists no closed form representation of the Cumulative Distribution Function (CDF) for a Normal (Gaussian) Distribution; however, Microsoft® Excel contains a built-in approximation function for this purpose. Additionally, a reasonable second order polynomial approximation is given by:

$$\mathrm{D}_{\mathrm{Normal}}(x) \approx \begin{cases} 0.01 \text{ for } x \in (-\infty, \mu - 2.33\sigma] \\ 0.0903\left(\frac{x-\mu}{\sigma}\right)^2 + 0.4207\left(\frac{x-\mu}{\sigma}\right) + 0.5 \text{ for } x \in [\mu - 2.33\sigma, \mu) \\ 0.5 \text{ for } x = \mu \\ -0.0903\left(\frac{x-\mu}{\sigma}\right)^2 + 0.4207\left(\frac{x-\mu}{\sigma}\right) + 0.5 \text{ for } x \in (\mu, \mu + 2.33\sigma] \\ 0.99 \text{ for } x \in [\mu + 2.33\sigma, \infty) \end{cases}$$ **Eqn. 10**

The Probability Density Function (PDF) and the Cumulative Distribution Function (CDF) for the Normal Distribution described by $\mathbf{S}_{\mathbf{EV}}(s)$ are graphed below in Figure 5 and Figure 6 respectively.

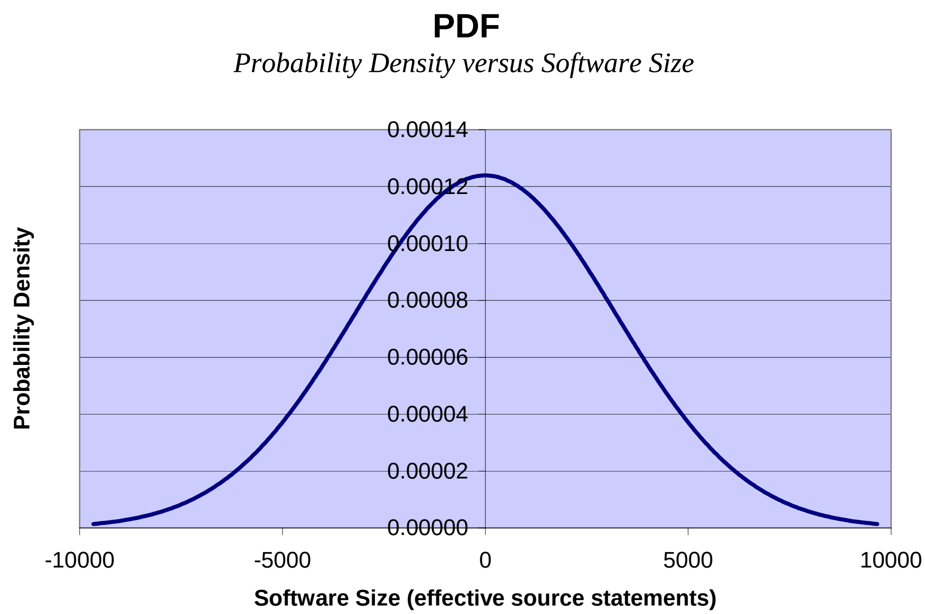

Figure 5: PDF of a Normal Distribution Described by $\mathrm{S}_{\mathrm{U}}(s)$

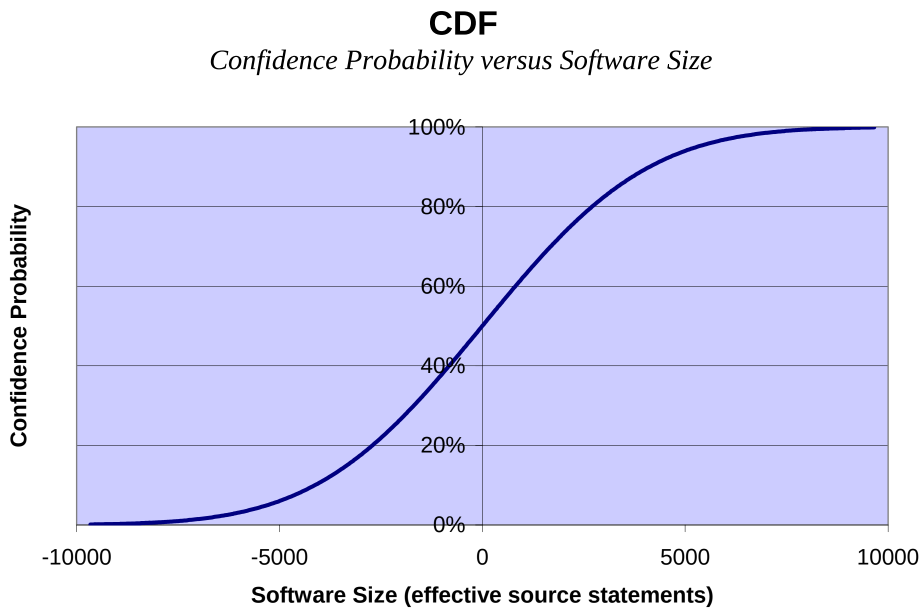

Figure 6: CDF of a Normal Distribution Described by $\mathbf{S}_{\mathbf{U}}(s)$

Combining Size Growth and Size Estimation Variability

Based on our definitions of size growth and of size estimation variability, we can sum our *best guess* size estimate $\mathrm{S}_{\mathrm{M}}(s)$, our size growth, a Triangular Distribution described by $\mathbf{S}_{\mathbf{G}}(s)$, and our size estimation variability, a Normal Distribution described by $\mathbf{S}_{\mathbf{EV}}(s)$; the result being our estimated size distribution of unknown type and described by the parameter vector $\mathbf{S}(s)=[\mu \quad \sigma]$, μ being its arithmetic mean and σ being its standard deviation. In order to solve for μ and σ we can take advantage of two statistical theorems as described in [2] and [1], one for expectation E that yields μ and one for variance V that yields σ^2. Each can be applied to a series of independently[11] distributed random variables X_i:

$$\mathrm{E}\left(\sum_{i=1}^{n} X_i\right) = \sum_{i=1}^{n} \mathrm{E}\left(X_i\right) \qquad \textbf{Eqn. 11}$$

and

$$\mathrm{V}\left(\sum_{i=1}^{n} X_i\right) = \sum_{i=1}^{n} \mathrm{V}\left(X_i\right) \qquad \textbf{Eqn. 12}$$

---

[11] Independence is a necessary prerequisite for the variance theorem; however, it is not a necessary prerequisite for the expectation (mean) theorem.

Given our series of independent random variables $\mathrm{S_M}(s)$, $\mathbf{S_G}(s)$, $\mathbf{S_{EV}}(s)$:

$$\mu_{\mathrm{S_M}(s)} = \mathrm{S_M}(s) \qquad \textbf{Eqn. 13}$$

$$\mu_{\mathbf{S_G}(s)} = \frac{0+0+\mathrm{S_M}(s)\mathrm{G}(s)}{3} = \frac{\mathrm{S_M}(s)\mathrm{G}(s)}{3}$$

$$\mu_{\mathbf{S_{EV}}(s)} = 0$$

$$\therefore \mu_{\mathbf{S}(s)} = \mathrm{S_M}(s) + \frac{\mathrm{S_M}(s)\mathrm{G}(s)}{3} = \frac{\mathrm{S_M}(s)\left(\mathrm{G}(s)+3\right)}{3}$$

and

$$\sigma_{\mathrm{S_M}(s)} = 0 \qquad \textbf{Eqn. 14}$$

$$\sigma_{\mathbf{S_G}(s)} = \sqrt{\frac{L^2+M^2+H^2-LH-LM-MH}{18}} = \sqrt{\frac{\left(\mathrm{S_M}(s)\mathrm{G}(s)\right)^2}{18}}$$

$$\sigma_{\mathbf{S_{EV}}(s)} = \frac{(30\%)\mathrm{S_M}(s)}{(2)(2.33)}$$

$$\therefore \sigma_{\mathbf{S}(s)} = \sqrt{\frac{\left(\mathrm{S_M}(s)\mathrm{G}(s)\right)^2}{18} + \left(\frac{(30\%)\mathrm{S_M}(s)}{(2)(2.33)}\right)^2}$$

Continuing our example size estimate taken at SRR where our *best guess* $S_{M\_SRR} = 50,000$ and our size growth factor $G_{SRR} = 0.61$:

$$\mathbf{S_{SRR}} = \left[\frac{S_{M\_SRR}\left(G_{SRR}+3\right)}{3} \quad \sqrt{\frac{\left(S_{M\_SRR}G_{SRR}\right)^2}{18} + \left(\frac{(30\%)S_{M\_SRR}}{(2)(2.33)}\right)^2}\right] \qquad \textbf{Eqn. 15}$$

$$\mathbf{S_{SRR}} = \left[\frac{50,000\left(0.61+3\right)}{3} \quad \sqrt{\frac{\left((50,000)(0.61)\right)^2}{18} + \left(\frac{(30\%)(50,000)}{(2)(2.33)}\right)^2}\right]$$

$$\therefore \mathbf{S_{SRR}} = \left[60,167 \quad 7,877\right]$$

We now know the mean or expected value (60,167 effective source statements) and standard deviation (7,877 effective source statements) of the statistical sum of the three contributors to our size estimate. If this were one small component in a larger whole consisting of many components, then we could take advantage of the Central Limit Theorem *"which states that the sum of a large number of independent random variables will be approximately normally distributed almost regardless of their*

individual distributions."[2] Unfortunately, we don't have a large number of independent random variables in this example; thus, if we wish to extract probability / confidence information from our size estimate distribution, we are left with a problem that is best solved by a calculator or a software product that uses simulation.

Summary and Conclusion

Purpose Revisited

This paper proposed definitions for and the relationship between two key attributes of software size estimates: ***growth*** and ***estimation process variability***, both being distributions, the dispersions of which decrease as a function of project progress.

Areas for Further Study

The following are suggestions for furthering the discussion of software size growth and uncertainty:

- Collect more (and more continuous) size estimation data and use it to strengthen size growth factor functions.
- Investigate making the conceivable range of the size estimation variability distribution be a function of project progress (i.e., factor in the notion of project maturity and associated learning).
- Investigate relevant methods and techniques, avoiding simulation, that provide probability / confidence information from distributions that are the statistical sum of a small number of constituent distributions (i.e., the resulting distribution is unlikely to be a Normal Distribution).

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Biography

Michael A. Ross has over 30 years of practical experience in software engineering as a developer, manager, process champion, consultant, instructor, and award-winning international speaker.

Mr. Ross is currently the Chief Engineer of Galorath Incorporated, makers of the SEER suite of estimation tools, where, for the past three years, he has been responsible for the advancement and realization of the technology aspects of Galorath's mission and vision.

Prior to joining Galorath, Mr. Ross was Vice President of Education Services for Quantitative Software Management, Inc. (makers of the SLIM suite of software estimating tools). He was responsible for the development and delivery of all QSM training. During his seven-year tenure with QSM, he served as one of the company's primary consultants and analysts working with Fortune 500 companies and government agencies in the areas of software measurement, sizing, estimating, tracking, forecasting, and benchmarking.

Mr. Ross, during 17 years with Honeywell Air Transport Systems (formerly Sperry Flight Systems) and 2 years with Tracor Aerospace, developed or managed the development of embedded software for avionics systems installed various commercial airplanes including the Boeing 737-500, 757, 767, 777, the Douglas MD-11, the Lockheed L1011-500, the British Aerospace BAe-146, the Airbus A320; and for expendable countermeasures systems installed in various military aircraft and missiles. He also co-founded Honeywell Air Transport Systems' process improvement team (later to become its SEPG), served as its focal for software project management process improvement, and served as a Honeywell corporate SEI CMM assessor.

Mr. Ross did his undergraduate work at the United States Air Force Academy and Arizona State University, receiving a Bachelor of Science in Computer Engineering. He is a member of the Project Management Institute (PMI), the Institute of Electrical and Electronics Engineers (IEEE), the International Function Points Users Group (IFPUG), the International Society of Parametric Analysts (ISPA), the Society of Cost Estimating and Analysis (SCEA), the Arizona Software Association, and the Phoenix area Software Process Improvement Network.

Parametric Project Monitoring and Control:

Performance-Based Progress Assessment and Prediction

Presented by:
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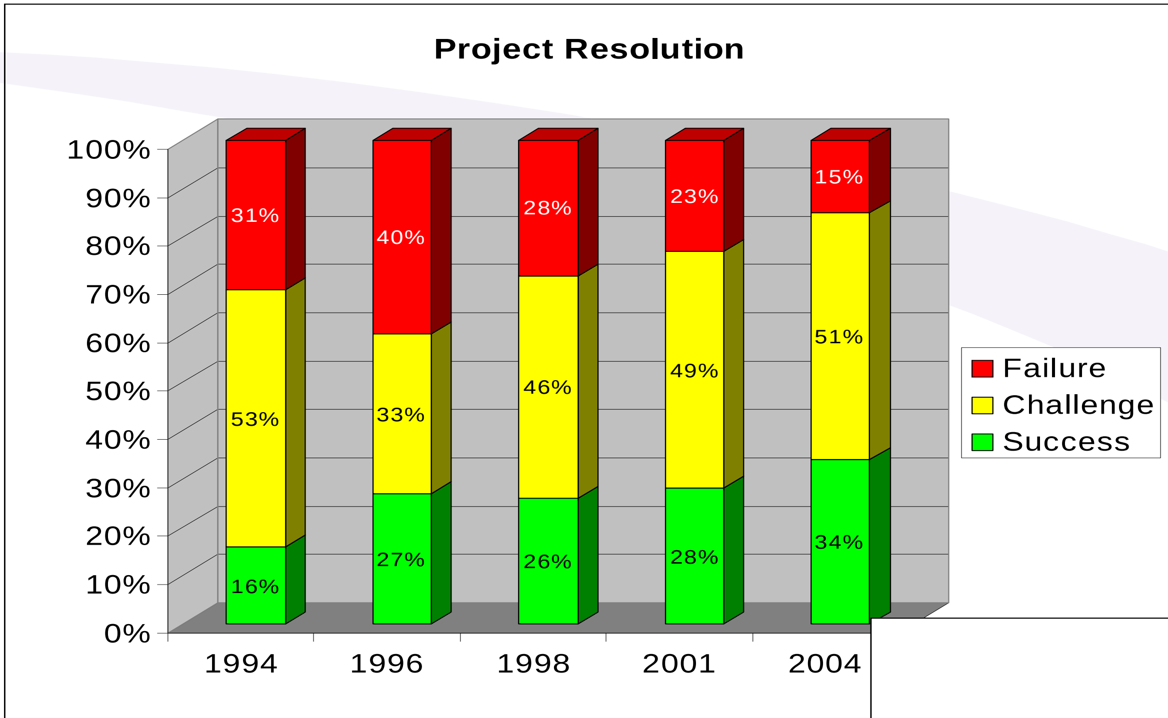
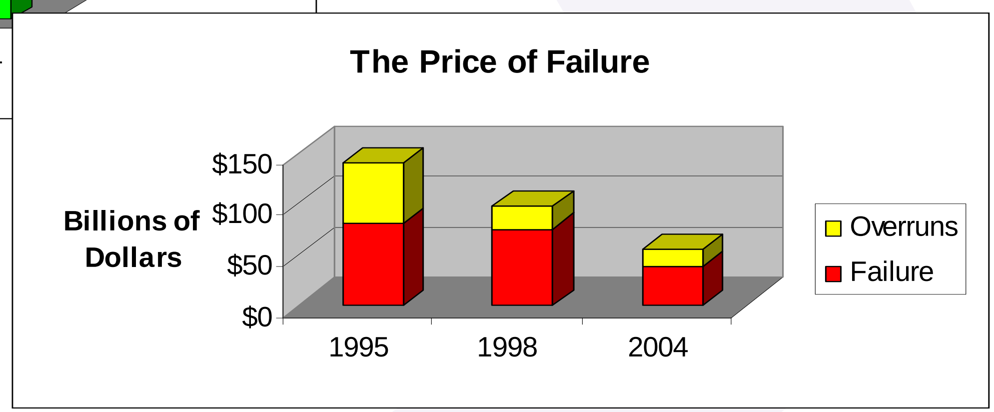
Summary

- **Software projects fail more often than not**
- **Project success ← Good management**
- **Measurement objectifies management**
- **Software projects are governed by dynamic properties**
  - Properties currently accounted for in the Project Planning process
  - ***Properties should also be accounted for in the Project Monitoring and Control process***
- **Project Monitoring ← Performance Measurement**
- **4-D Earned Value objectifies progress**
- **Project Control ← Control Limits**
- **Re-Baselining ← Performance-Based Forecasting**
- ***Communication is essential to successful project management***

Things are Getting Better; however, There's Still Room For Improvement



- **Success**: The project is completed on time and on budget, with all features and functions
- **Challenge**: Over budget, over time, offers fewer features than originally specified
- **Failure**: Project is cancelled prior to completion



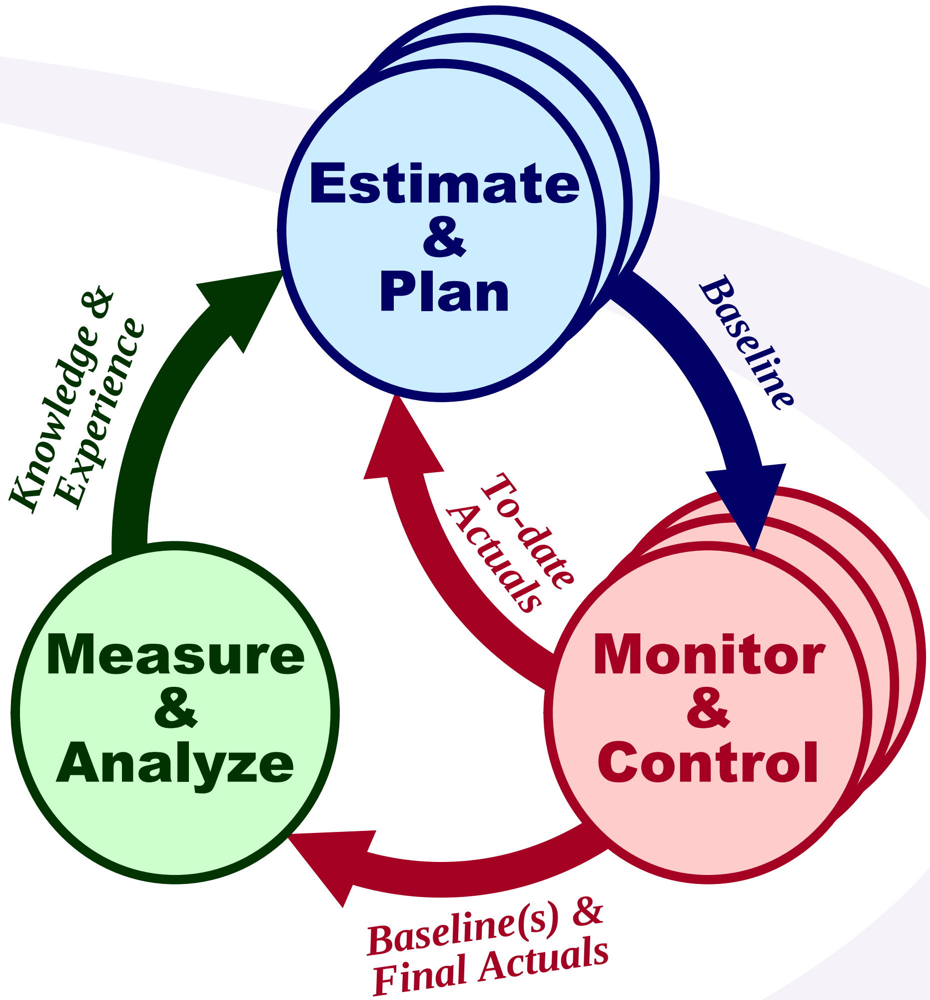
How does ineffective management of resources (people, time, $) contribute to this problem?

Source: Standish Group International, Inc. "CHAOS" studieswww.standishgroup.com

Mnemonic Aid for Software Project Management

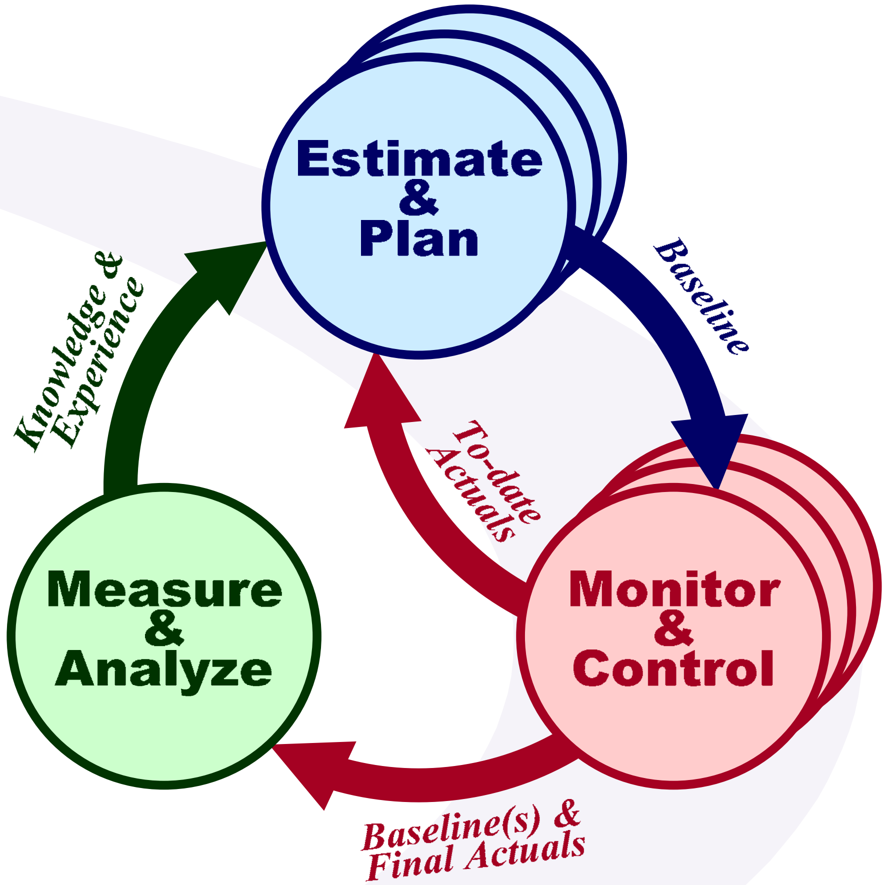
- **P*lanning*** **– estimating, scheduling**
- **R*esourcing*** **– interviewing, hiring, motivating**
- **O*rganizing*** **– establishing interpersonal communication paths and rules, mapping resources to tasks**
- **T*raining*** **– teaching, mentoring**
- **E*quipping*** **– acquiring and allocating equipment, tools, materials, supplies, products etc.**
- **C*ontrolling*** **– directing, measuring, correcting and/or replanning**
- **T*ransitioning*** **– delivering, reviewing, analyzing, archiving**

Project Management Context

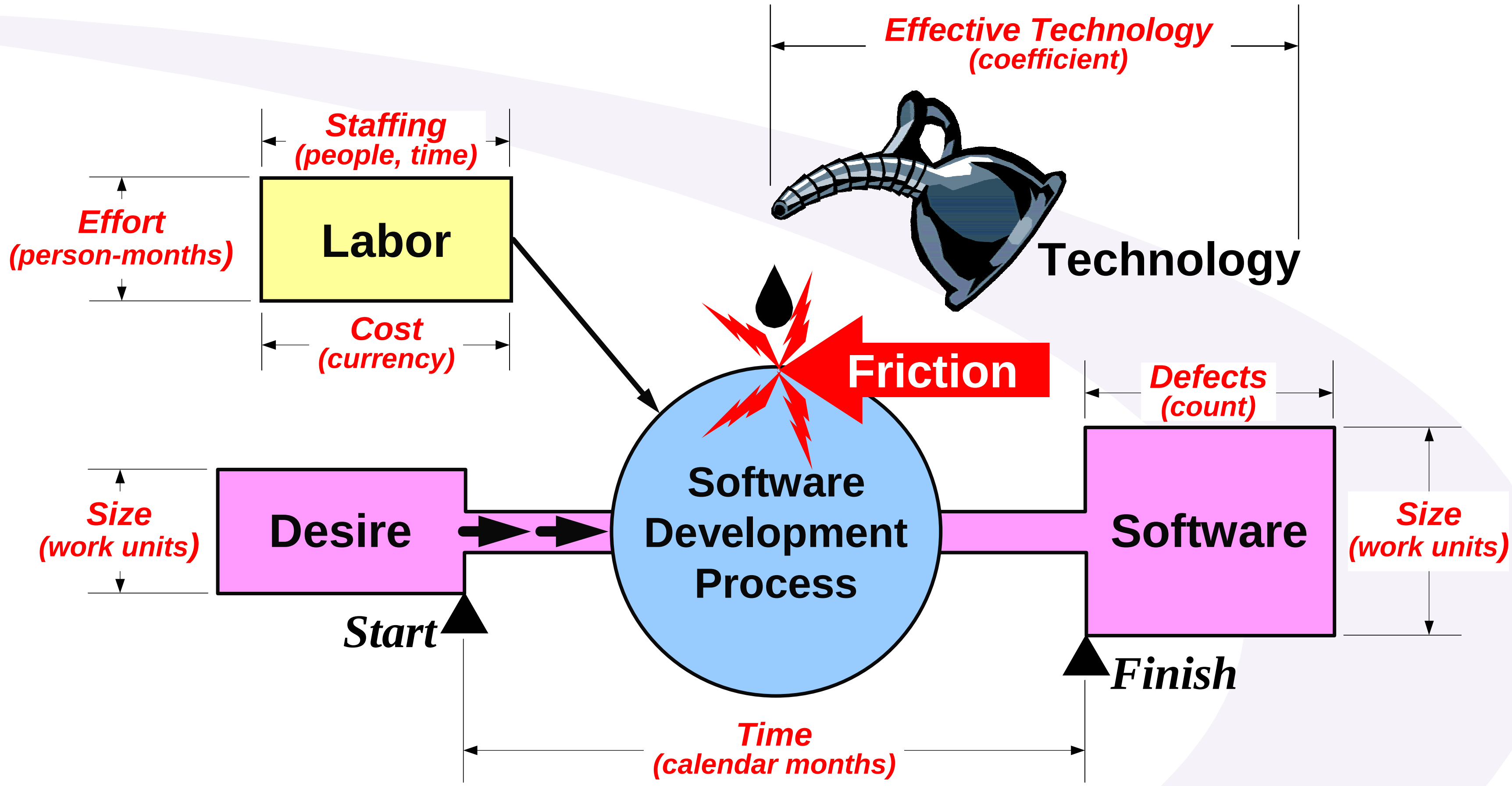


Process Focus (CMMI™)

- **Project Planning**
  - Establish Estimates
  - Develop a Project Plan
  - Obtain Commitment to the Plan
- **Project Monitoring and Control**
  - Monitor Project Against Plan
  - Manage Corrective Action to Closure
- **Measurement and Analysis**
  - Align Measurement and Analysis Activities
  - Provide Measurement Results



Software Development and Measurement



Fundamental Measures

Size

Effective Technology

Time

Effort → Cost, Staffing

Defects

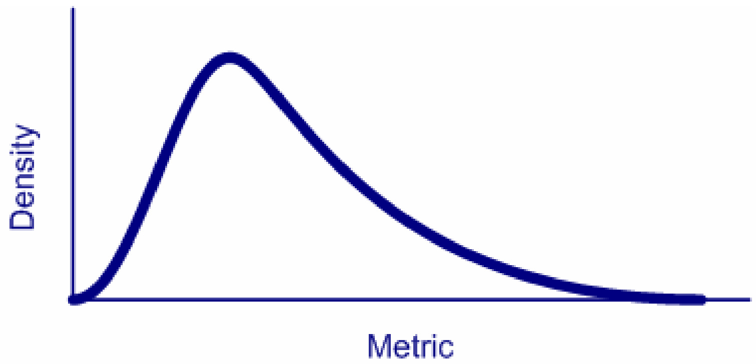
Estimate Defined

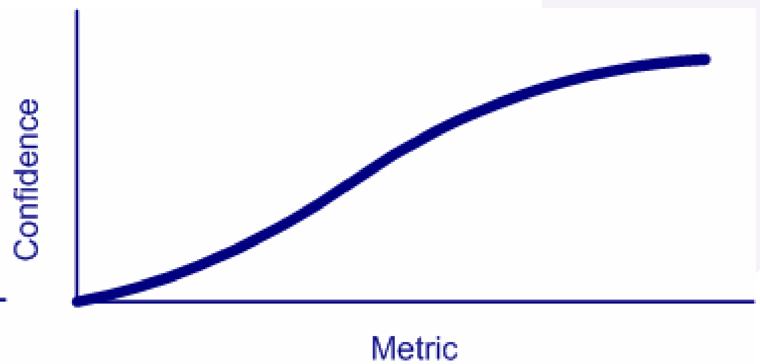
es·ti·mate (es′ti mit), *n.*

an approximate *judgment* or *calculation*, as of the value or amount of something

a prediction that is equally likely to be above or below the actual result (Tom DeMarco)

A WELL FORMED ESTIMATE IS A DISTRIBUTION

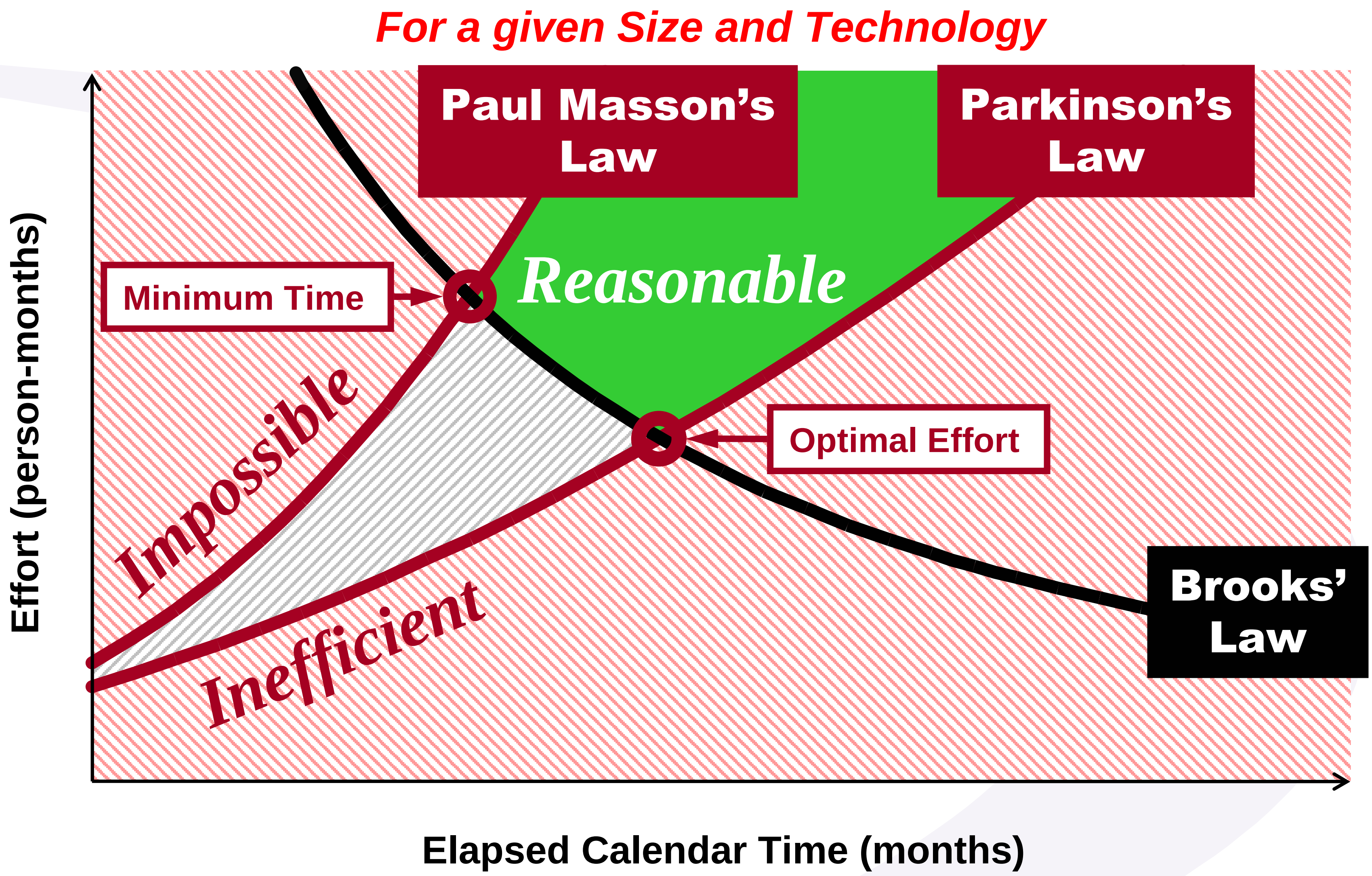




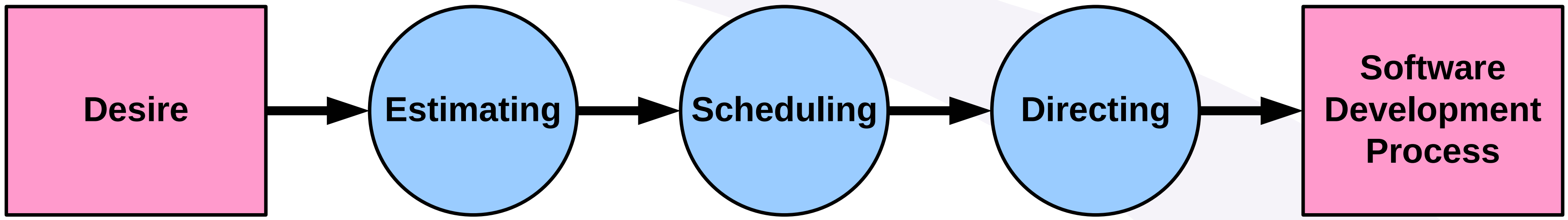
3 Laws of Software Development Dynamics

- **Brooks' Law (Software Equation)**
  - ***Adding people to a late project makes it later.***
  - Development time (duration) and development effort (labor) are not linearly interchangeable.
- **Paul Masson's Law Applied to Software Development (Minimum Time Equation)**
  - ***No [software] before its time.***
  - Each and every project, by its nature (technical difficulty), can effectively handle only so much staffing acceleration; therefore, there exists, for each and every project, some minimum achievable development time.
- **Parkinson's Law (Optimal Effort Equation)**
  - ***Work expands so as to fill the time available for its completion.***
  - There exists, for each and every project, some point of maximum productivity; i.e., some point that represents the most efficient use of labor on the project.

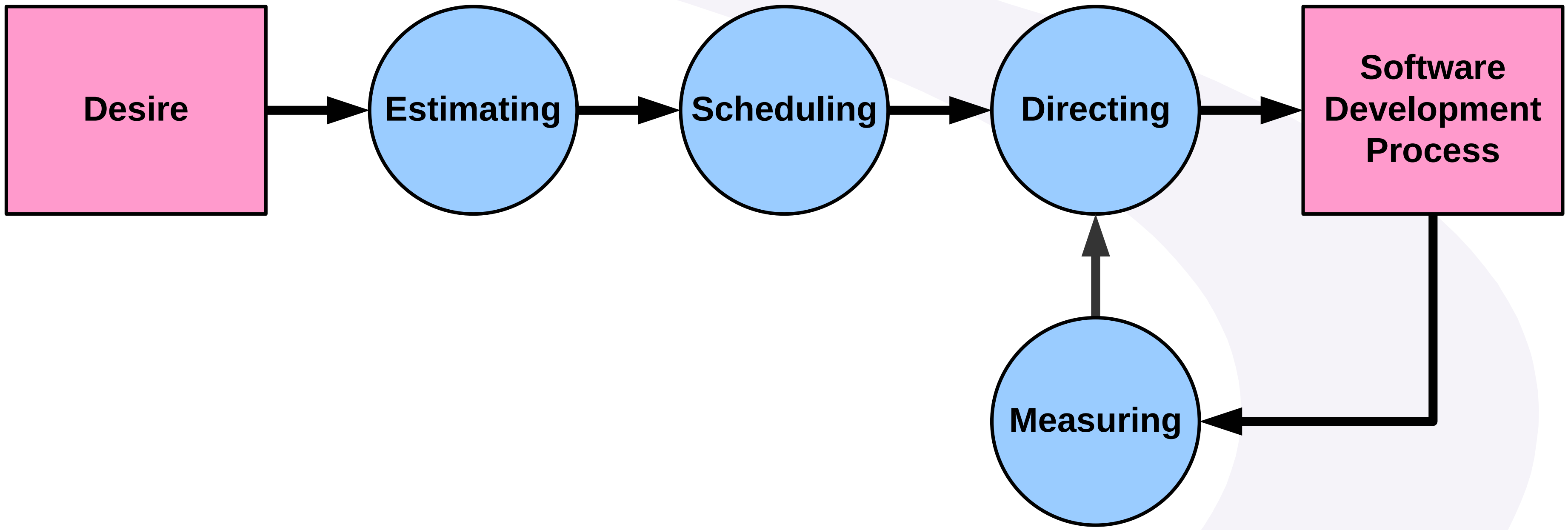
Software Development Dynamics



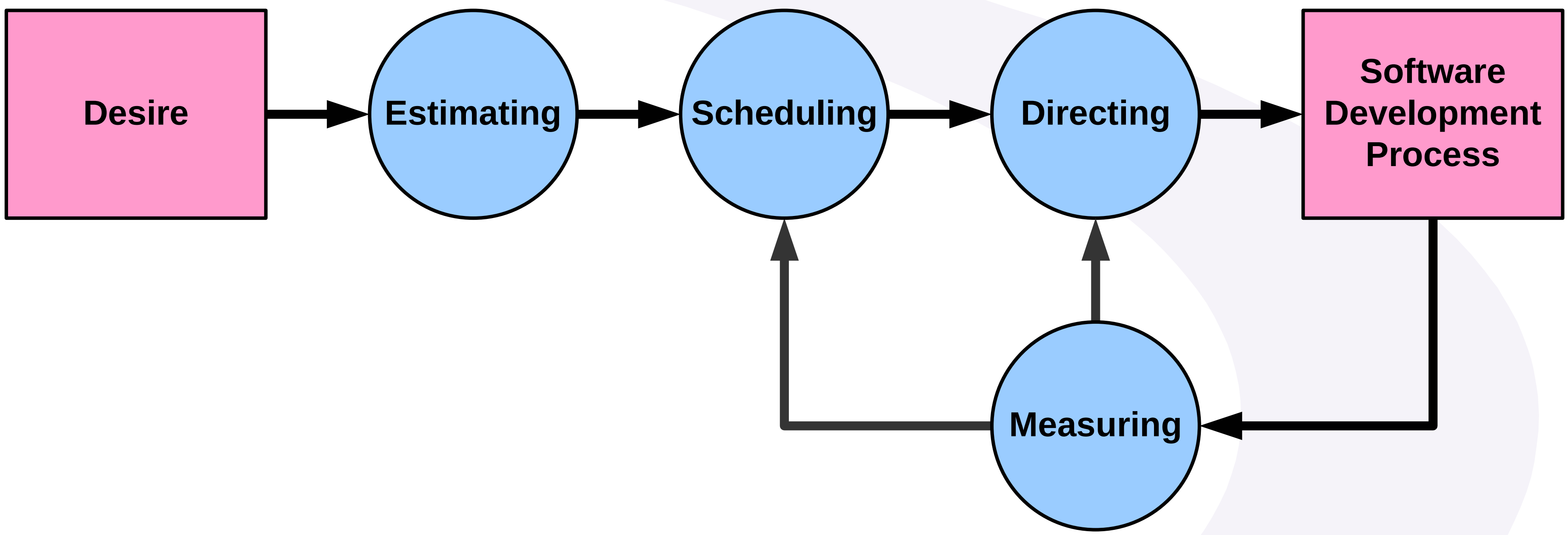
Software Project Management Out of Control Process



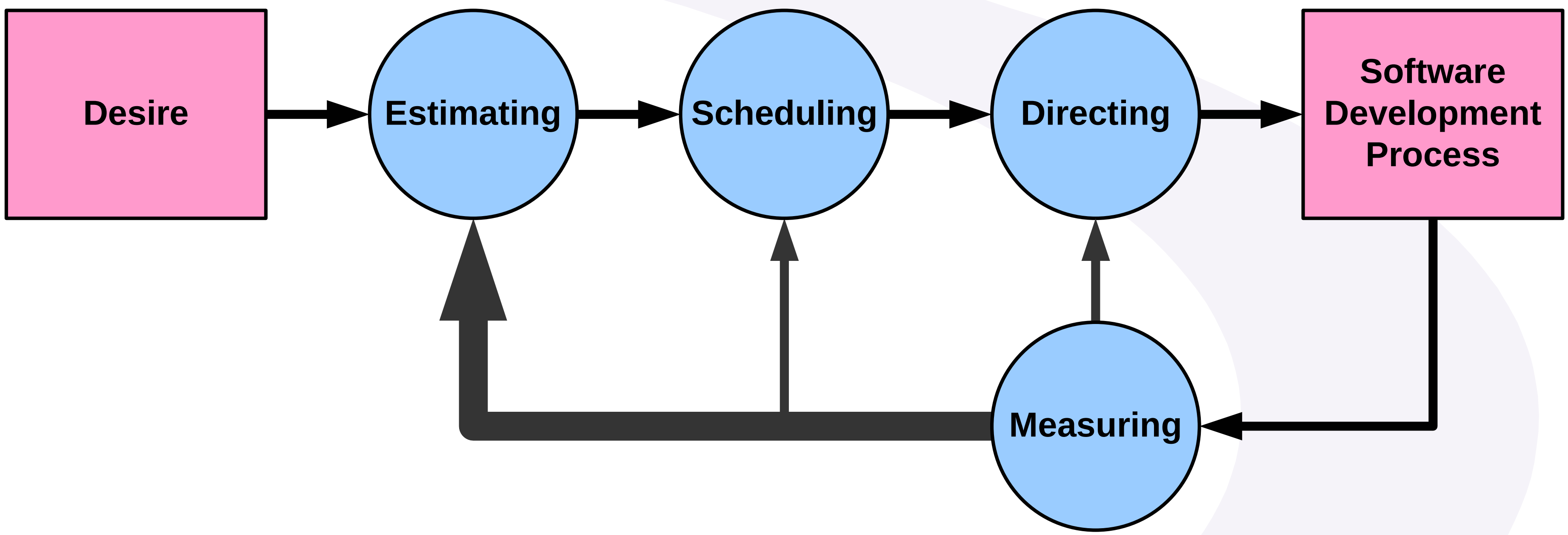
Software Project Management
Ad Hoc Process



Software Project Management Partially Managed Process



Software Project Management
Fully Managed Project



Performance Measurement: Measures and Metrics

- **Fundamental Cost of Work Measures**
  - ***Baseline Budget*** – Budget at Completion (BAC)
  - ***Planned –*** Budgeted Cost of the Work Scheduled (BCWS)
  - ***Earned –*** Budgeted Cost of the Work Performed (BCWP)
  - ***Spent –*** Actual Cost of the Work Performed (ACWP)
- **Variances (Differences between Cost of Work Measures)**
  - Schedule Variance (SV)
  - Cost Variance (CV)
  - Budget Variance (BV)
  - Time Variance (TV)

Performance Measurement: Measures and Metrics

- **Performance Indices – (Ratios Between Cost of Work Measures)**
  - Schedule Performance Index (SPI)
  - Cost Performance Index (CPI)
  - Budget Performance Index (BPI)
  - Time Performance Index (TPI)
  - Composite Performance Index (XPI)
  - To-Complete Performance Index (TCPI)
- **Status and Forecasting Metrics**
  - Estimate at Completion (EAC)
  - Estimate to Complete (ETC)

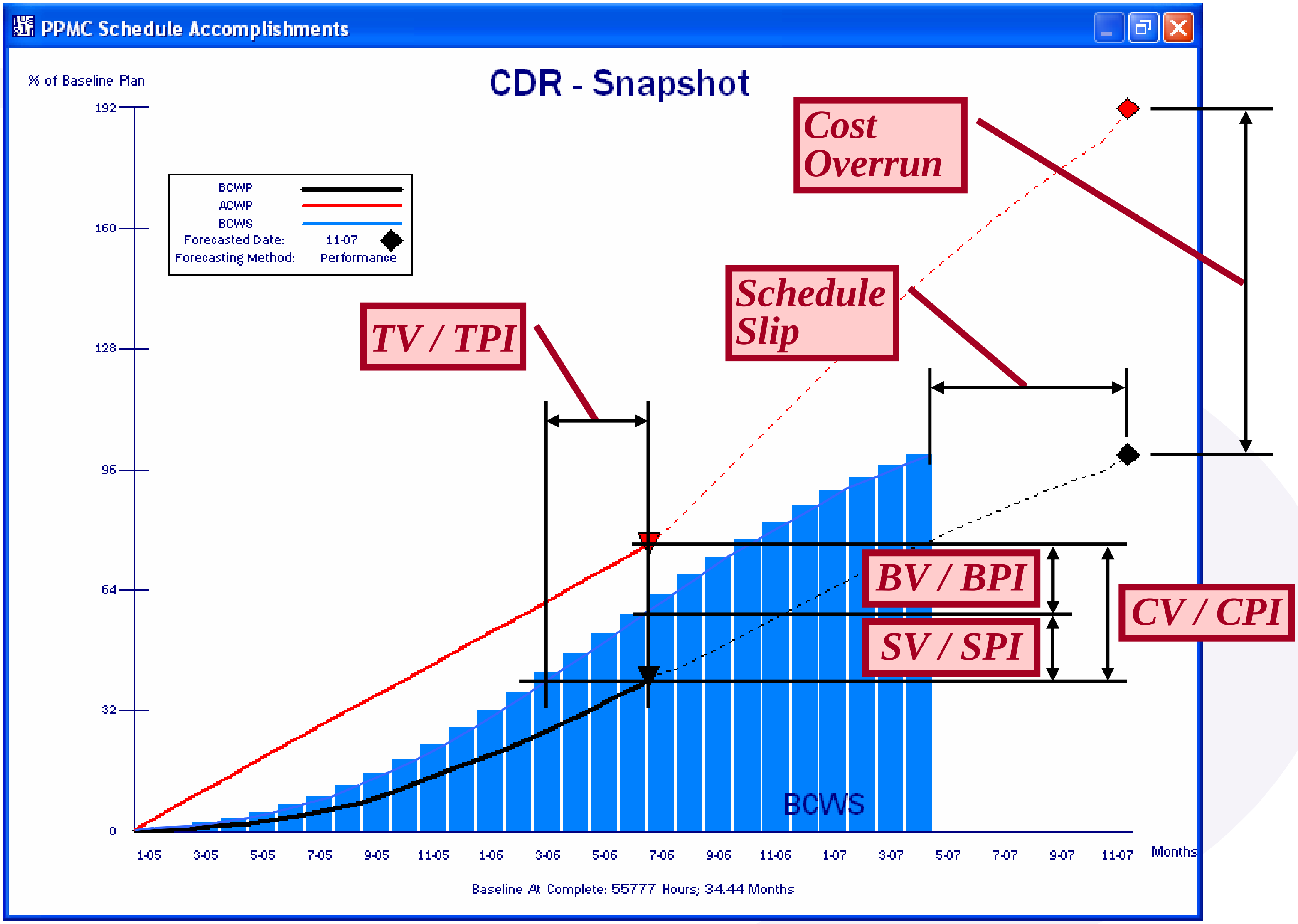
Three Unit Systems for Performance Measurement Values

- **Monitary Value – units of currency; e.g.:**
  - $
  - £
  - €
- **Effort Value – units of labor; e.g.:**
  - person-hours, staff-hours, effort-hours, labor-hours
  - person-months, staff-months, effort-months, labor-months
- **Normalized Value – unitless**
  - % of full scale

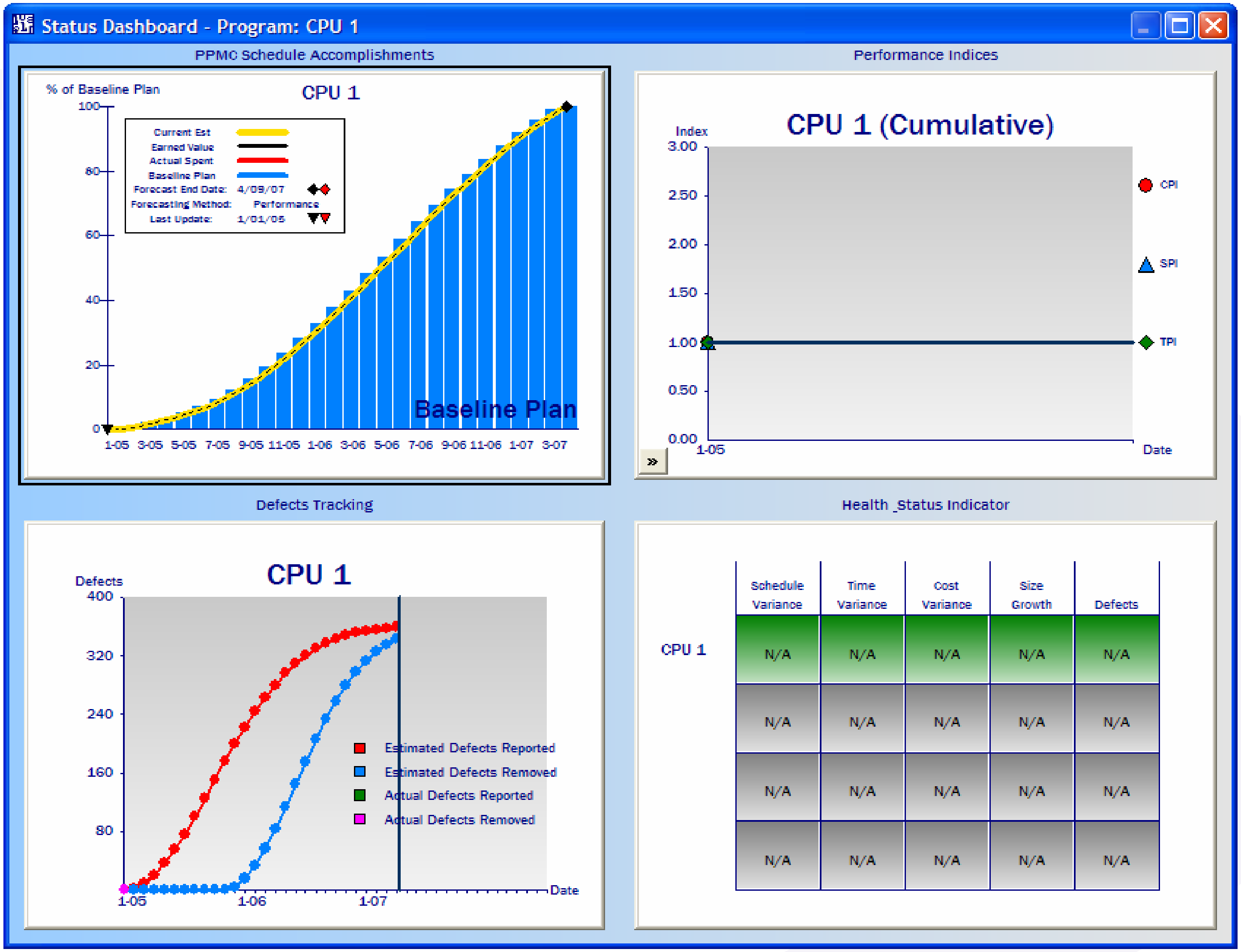
4-D Earned Value

- SDLC Primary Activity Completion
- Artifact Completion
- Milestone Completion
- Defect Discovery / Removal

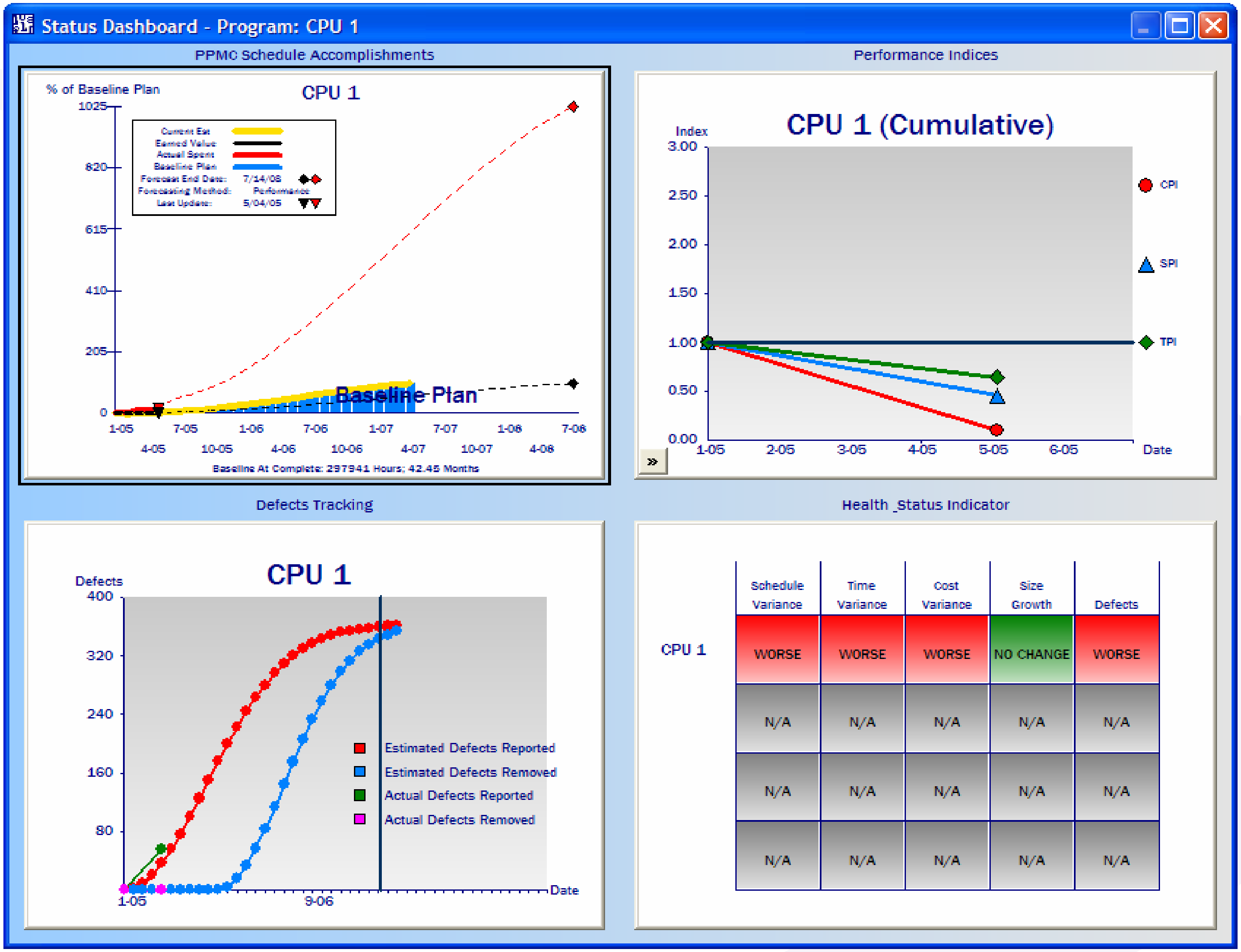
Schedule Accomplishments Chart



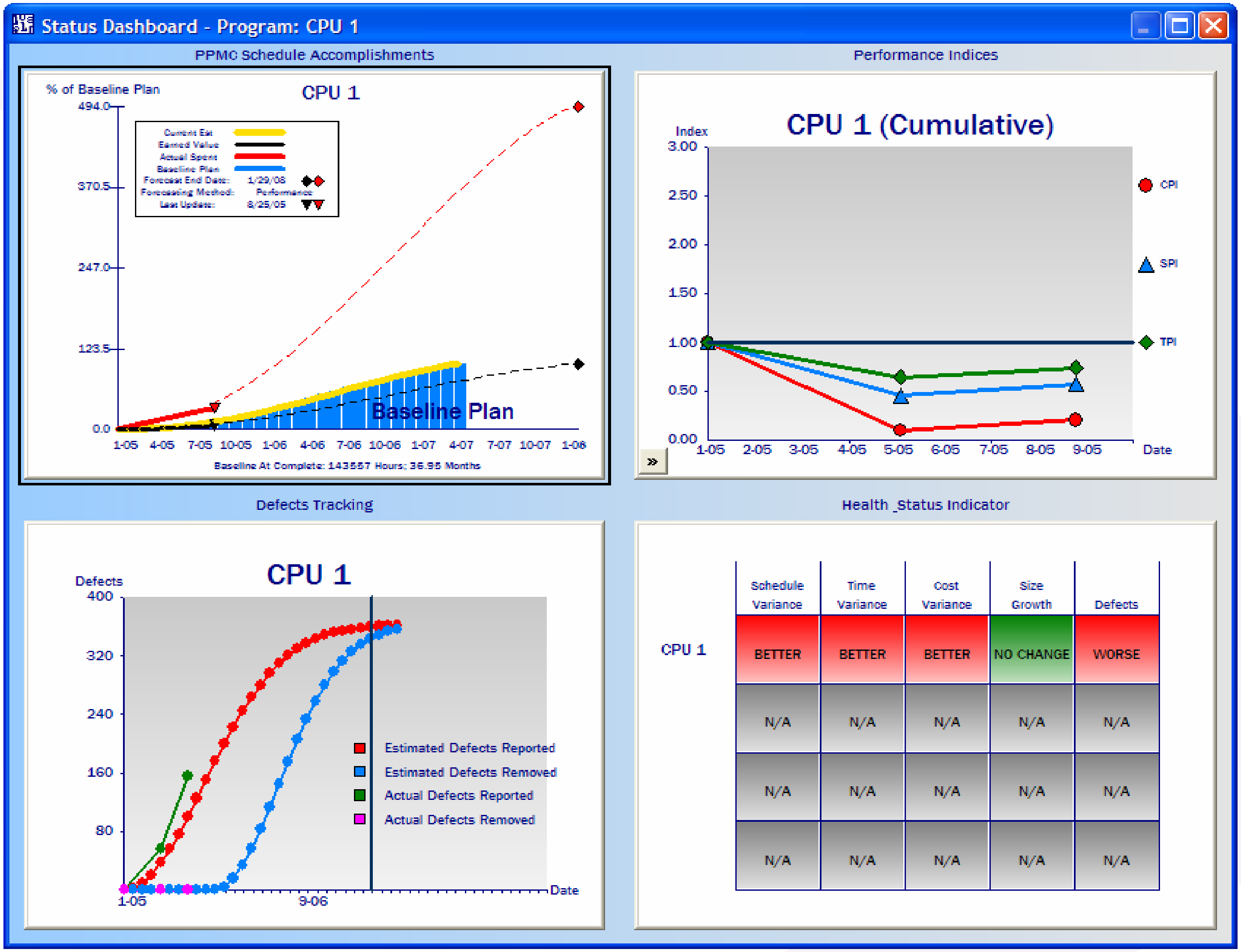
Example Project: Metrics Charts at Project Start (Initial Plan)



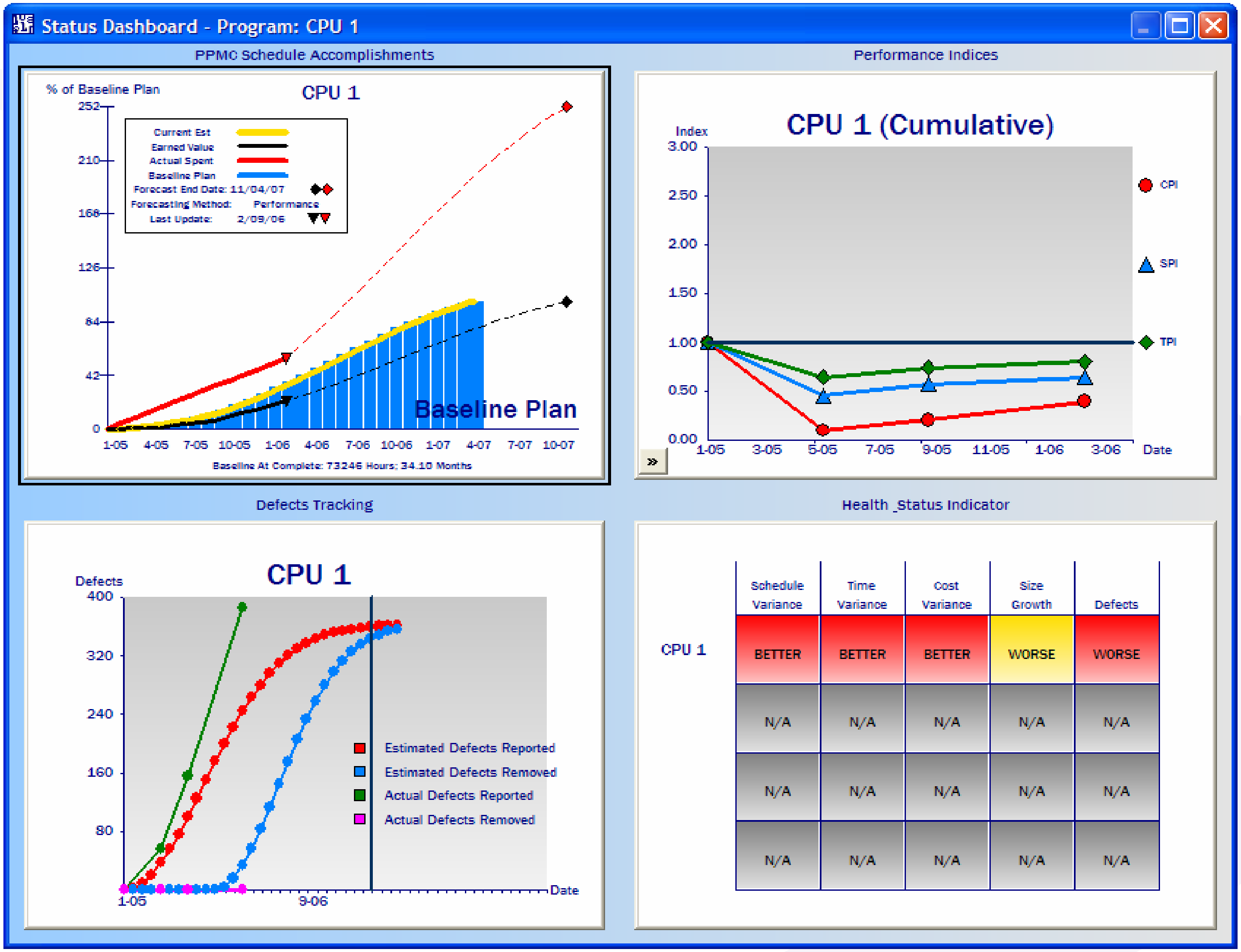
Example Project: Metrics Charts at System Design Review



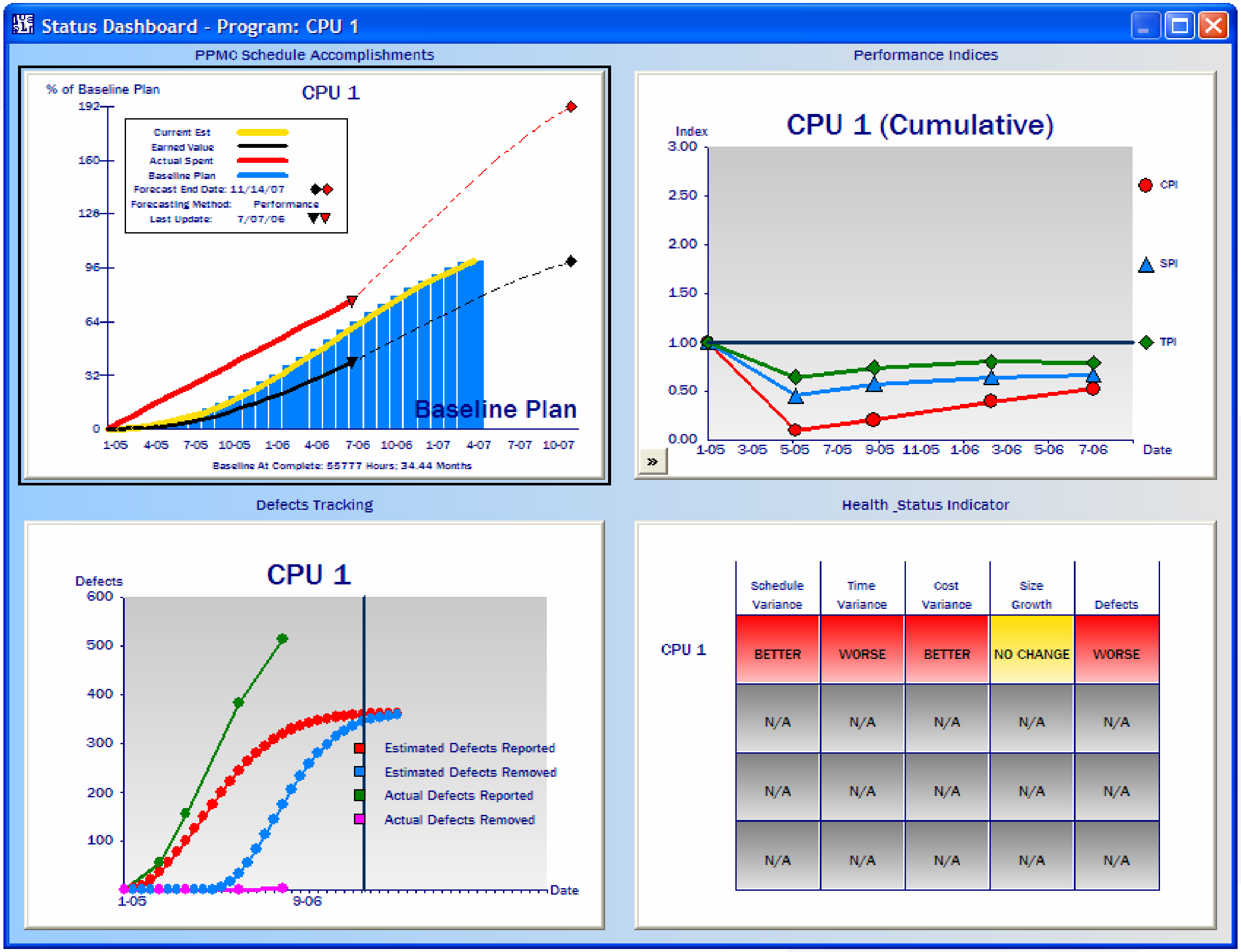
Example Project: Metrics Charts at Software Requirements Review



Example Project: Metrics Charts at Preliminary Design Review



Example Project: Metrics Charts at Critical Design Review

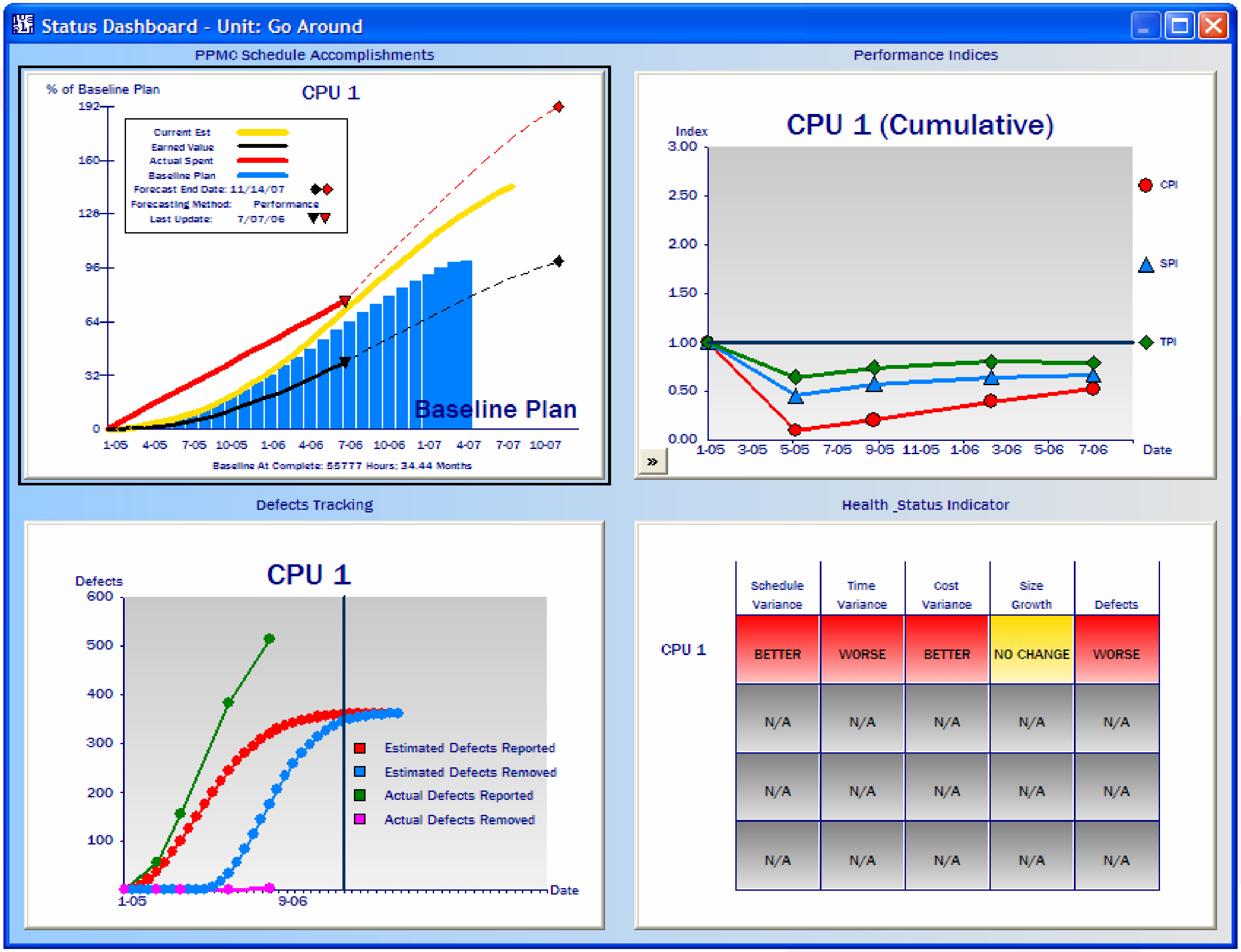


	Schedule Variance	Time Variance	Cost Variance	Size Growth	Defects
CPU 1	BETTER	WORSE	BETTER	NO CHANGE	WORSE
	N/A	N/A	N/A	N/A	N/A
	N/A	N/A	N/A	N/A	N/A
	N/A	N/A	N/A	N/A	N/A

Performance-Based Forecasting and Re-Baselining

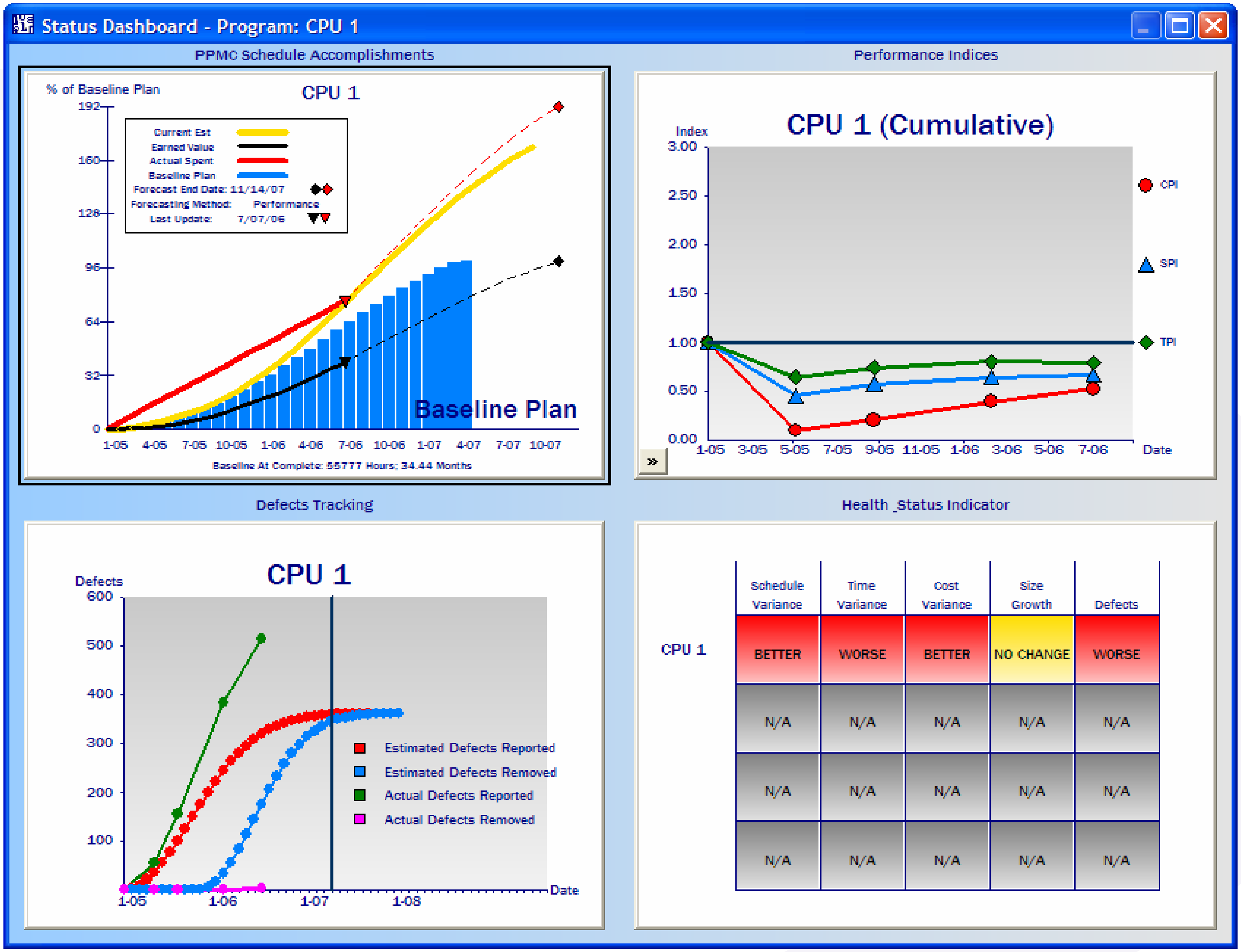
1. Start a new estimate
2. Update size estimate
3. Update technology assumptions
4. Update schedule assumptions
5. Update staffing assumptions
6. Update labor rate and FTE assumptions
7. Time now calibration
8. Communicate the results
9. Re-Baseline the project

Example Project: Metrics Charts Update Size Estimate

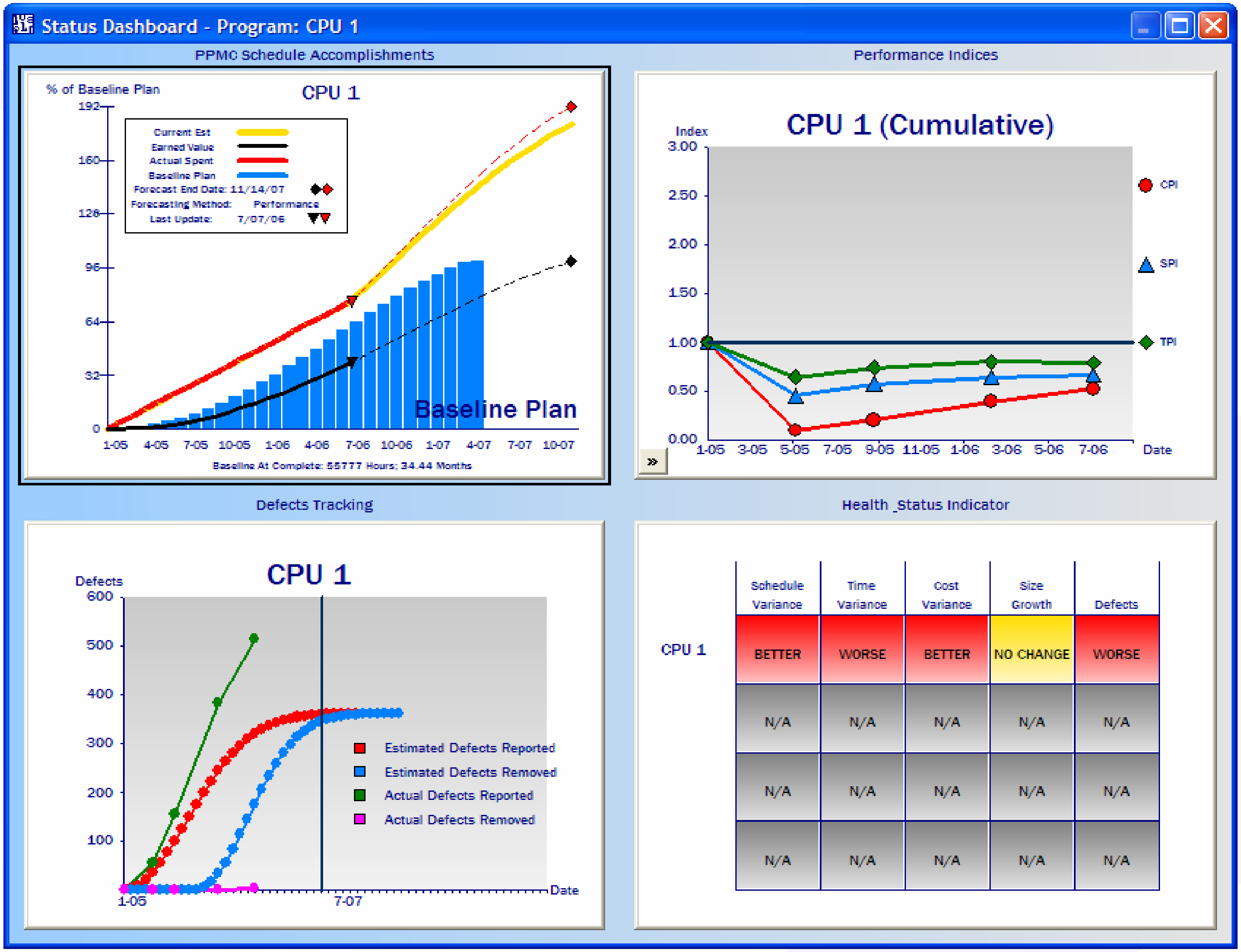


SEER

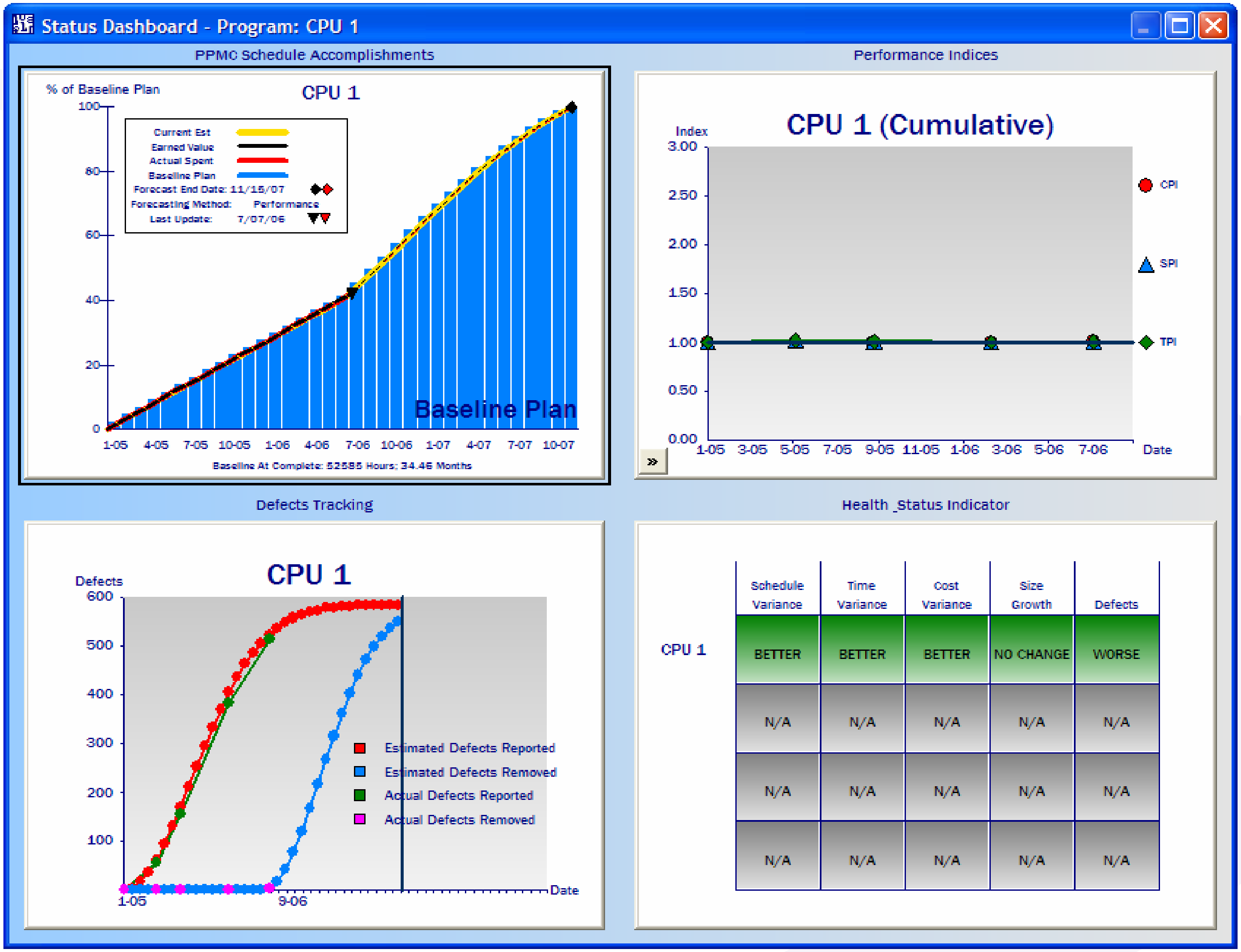
Example Project: Metrics Charts Update Technology Assumptions



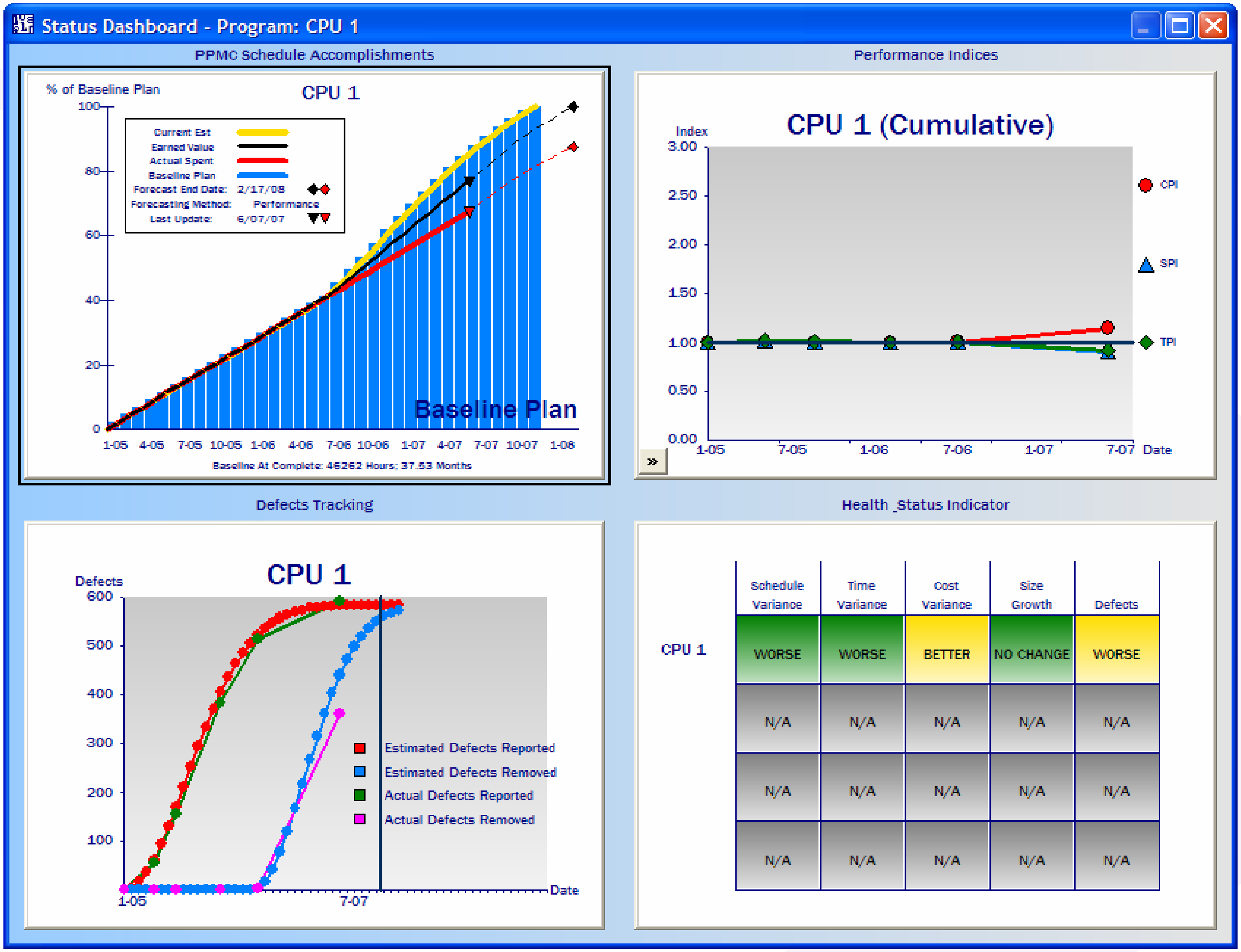
Example Project: Metrics Charts Update Staffing Assumptions



Example Project: Metrics Charts Re-Baseline the Project

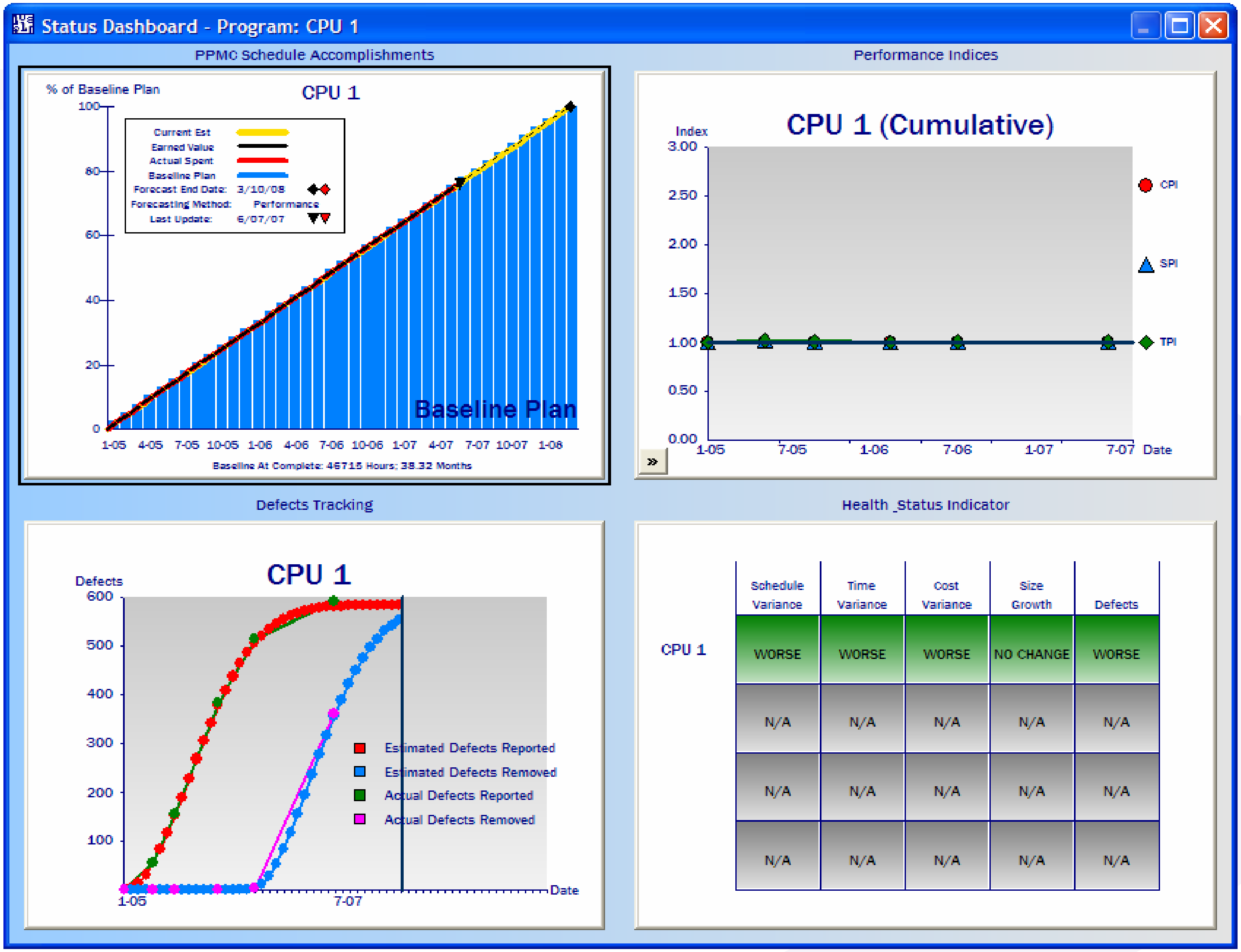


Example Project: Metrics Charts at Code & Unit Test Complete

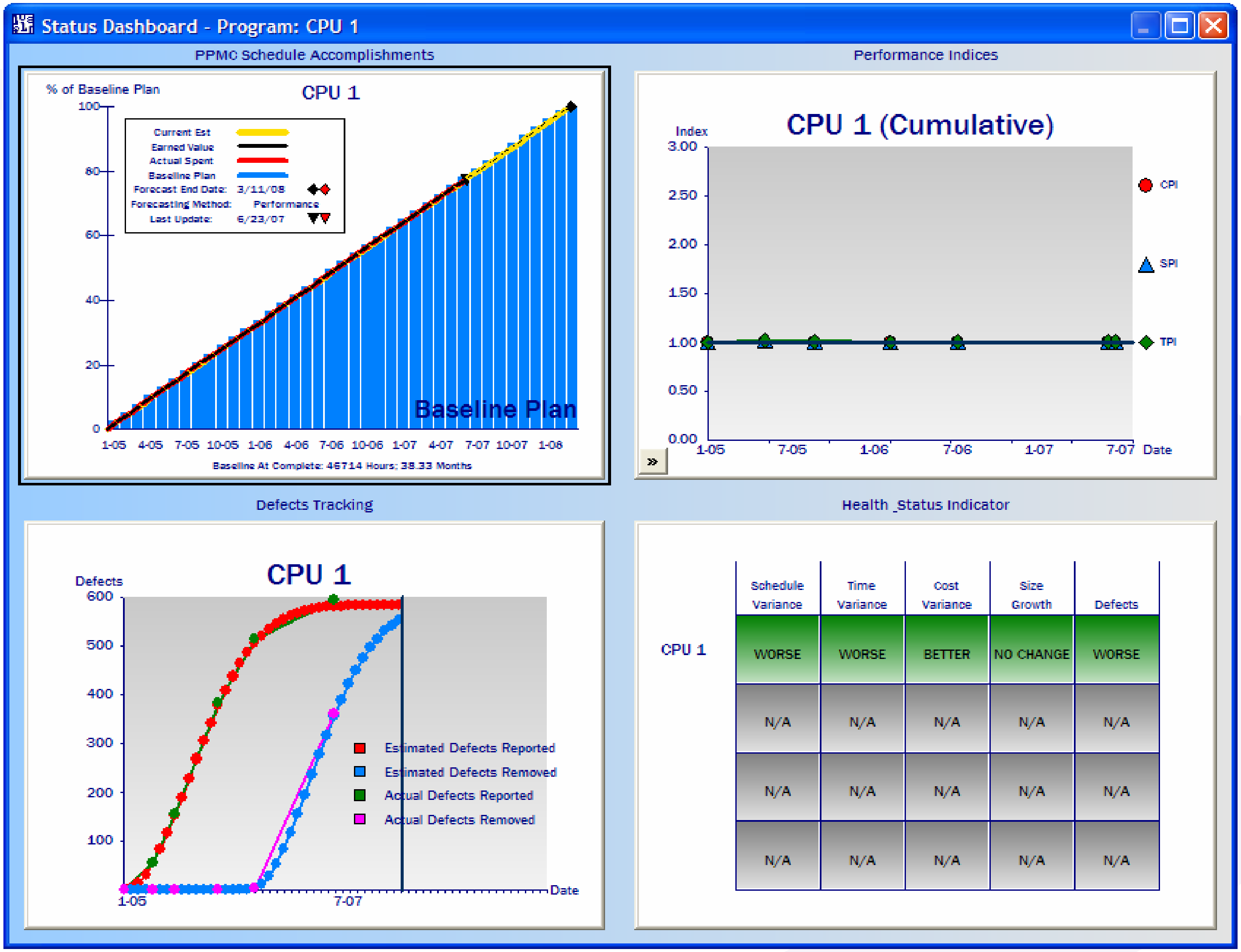


Example Project: Metrics Charts Update Staffing Assumptions

Example Project: Metrics Charts
Re-Baseline the Project

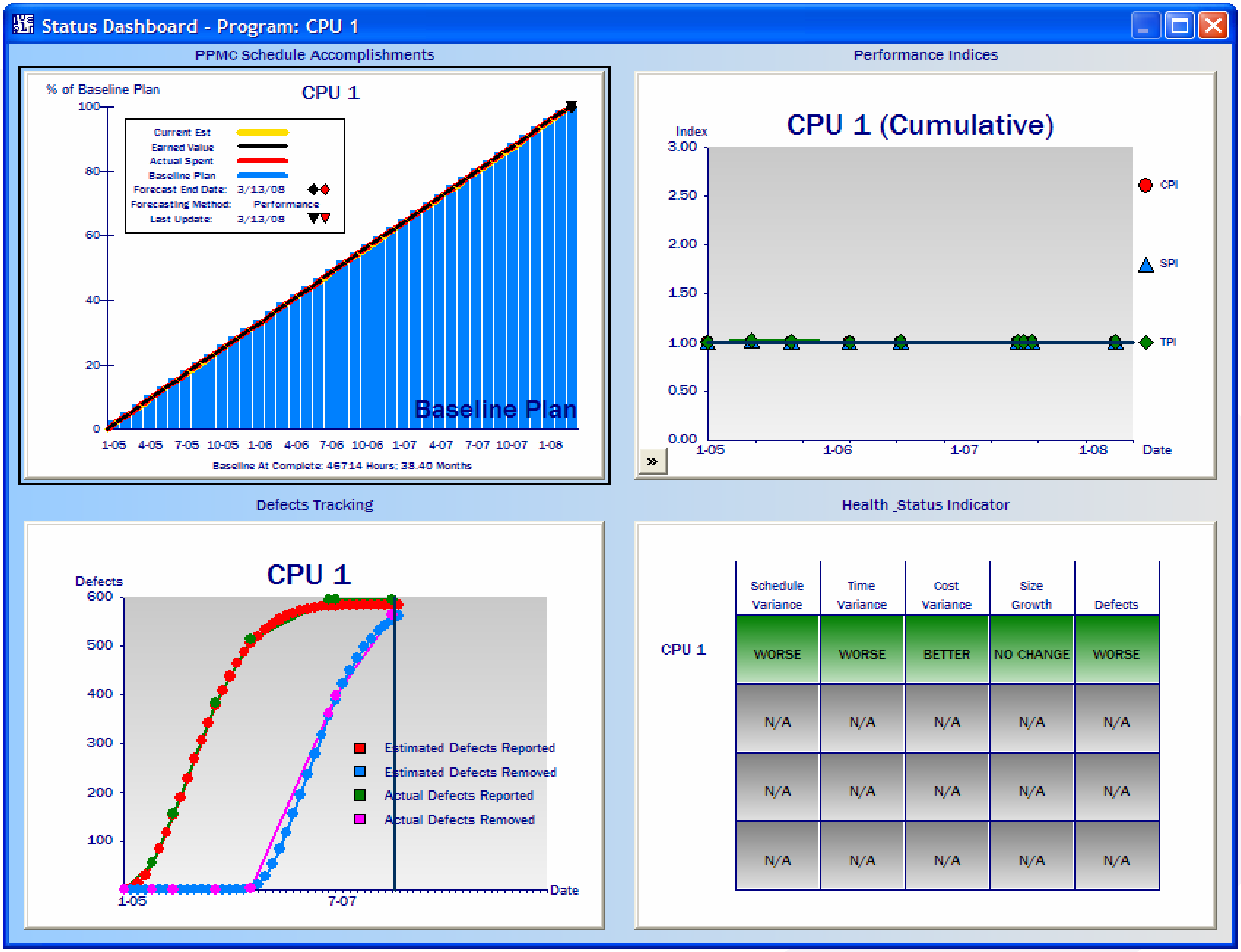


Example Project: Metrics Charts at Component Int. & Test Complete



Example Project: Metrics Charts at Program Test Complete

Example Project: Metrics Charts at Project Finish (Initial Delivery)



Review

- **Software projects fail more often than not**
- **Project success ← Good management**
- **Measurement objectifies management**
- **Software projects are governed by dynamic properties**
  - Properties currently accounted for in the Project Planning process
  - ***Properties should also be accounted for in the Project Monitoring and Control process***
- **Project Monitoring ← Performance Measurement**
- **4-D Earned Value objectifies progress**
- **Project Control ← Control Limits**
- **Re-Baselining ← Performance-Based Forecasting**
- ***Communication is essential to successful project management***

Parametric Project Monitoring and Control

Performance-Based Progress Assessment and Prediction

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Abstract. Performance Measurement (an integral part of Earned Value Management (EVM)) has, over at least the last two decades, become a gold standard process (i.e., best practice) for monitoring and controlling the progress of software development projects. It employs the fundamental measurement-based command/feedback principals of control theory to increase the probability that a project's actual performance matches its expected (planned) performance; i.e., that a project is delivered on time and within budget or, at least, that there is an early warning of looming disaster. This process is generally well-understood by project managers and reasonably well supported by commercially-available tools. Experience with this process suggests an opportunity for significant process improvement by including established estimation methodology and algorithms as part of the forecasting and re-baselining activities performed during the project monitoring and control process. This paper first reviews the fundamentals of software project management and of Performance Measurement (including some proposed extensions to the notion of earning value) and then proposes a process called Parametric Project Monitoring and Control (PPMC) whereby accepted algorithms currently used for software cost and schedule estimation during the project planning process are incorporated into the forecasting and re-baselining processes to yield a more-realistic time-range prediction of the project's cost and duration.

Introduction

Purpose

The purpose of this paper is to first review the fundamentals of software project management and of Performance Measurement (including some proposed extensions to the notion of earning value) and then to propose a process called Parametric Project Monitoring and Control (PPMC) whereby accepted algorithms currently used for software cost and schedule estimation during the project planning process are incorporated into the Estimate at Completion (EAC) calculation to yield a more-realistic time-range prediction of the project's cost and duration.

Scope

This paper applies to the project management aspects of the software development process; particularly to those Level 2 process areas referred to in the Carnegie Mellon University Software Engineering Institute's (SEI) Capability Maturity Model® Integration (CMMI™) for Project Planning, Project Monitoring and Control, and Measurement and Analysis [1]. While the scope and focus of this paper is the software development process, one could imagine how these ideas can be readily applied to hardware and system development as well.

Background

Performance Measurement (an integral part of Earned Value Management (EVM)) has, over at least the last two decades, become a gold standard process (i.e., best practice) for monitoring and controlling the progress of software development projects. It employs the fundamental measurement-based command/feedback principals of control theory to increase the probability that a project's actual performance matches its expected (planned) performance; i.e., that a project is delivered on time and within budget or, at least, that there is an early warning of looming disaster. This process is generally well-understood by project managers and reasonably well supported by commercially-available tools. ***Experience with this process suggests an opportunity for significant process improvement by including established estimation methodology and algorithms as part of the forecasting and re-baselining activities performed during the Project Monitoring and Control process.***

Software Project Management

The primary purpose of the software project management process is to ensure that its associated software development project is successful. Success, within this context, is

assumed to mean achieving or exceeding expectations; i.e., success occurs when the actual outcome matches (within a reasonable tolerance) the expected outcome [4].

The above definition of success, by virtue of its reference to expectations, implies the need for some sort of roadmap or plan; i.e., some sort of description of these expectations in terms of who, what, when, where, how, and why. It follows, then, that one of the software project management process's primary activities should be ***planning***.

Assuming correspondence between expectations and some sort of project plan, we can now assert that success occurs when the actual outcome matches this plan (within some reasonable tolerance). Ensuring that the actual outcome matches the plan must, therefore, be of primary concern to the software project management process. Ensuring this match implies influencing the actual outcome and/or changing the plan; therefore, one of the software project management process's primary activities should be ***controlling***.

Influencing the actual outcome is typically achieved by careful initialization, direction, and correction of the software development process and of the environment in which it is performed. Since the software development process is fueled primarily by labor (people), one of the software project management process's primary activities should be ***resourcing***. Since software development is, indeed, a process, it involves methods, skills/expertise, tools, and task flow. Therefore, the set of software project management process primary activities should also include ***organizing***, ***training***, and ***equipping***.

Finally, once the project is complete, we must deliver the product, determine whether or not the project was a success, and learn from all that was measured and experienced during the project. We therefore suggest that one of the software project management process's primary activities should be ***transitioning***; transitioning the project's product to the consumer and transitioning the project's knowledge and experience to the next project(s).

A useful mental device for remembering the above-described software project management process primary activities is the fact that the first letter of each activity name forms the word ***PROTECT***.

- **P*lanning* –** estimating, scheduling
- **R*esourcing* –** interviewing, hiring, motivating
- **O*rganizing* –** establishing interpersonal communication paths and rules, mapping resources to tasks
- **T*raining* –** teaching, mentoring
- **E*quipping* –** acquiring and allocating equipment, tools, materials, supplies, products etc.
- **C*ontrolling* –** directing, measuring, correcting and/or replanning

- ***T**ransitioning* **–** delivering, reviewing, analyzing, archiving

The software project management process, by ensuring project success, is *protecting* the sponsoring organization's investment in the project. Or, perhaps (I can't resist injecting a little gallows humor here), it is *protecting* the software project manager's job.

Mapping Software Project Management to the CMMI

If we slightly reorganize our ***PROTECT*** model such that the ***planning*** and ***controlling*** activities each subsume the appropriate aspects of ***resourcing***, ***organizing***, ***training***, and ***equipping***, then we are left with three top-level activities: ***planning***, ***controlling***, and ***transitioning***. These three activities can be one-to-one mapped with the Level 2 CMMI™ process areas for ***Project Planning***, ***Project Monitoring and Control***, and ***Measurement and Analysis***. Figure 1 depicts a proposed context model that illustrates the relationships between these process areas.

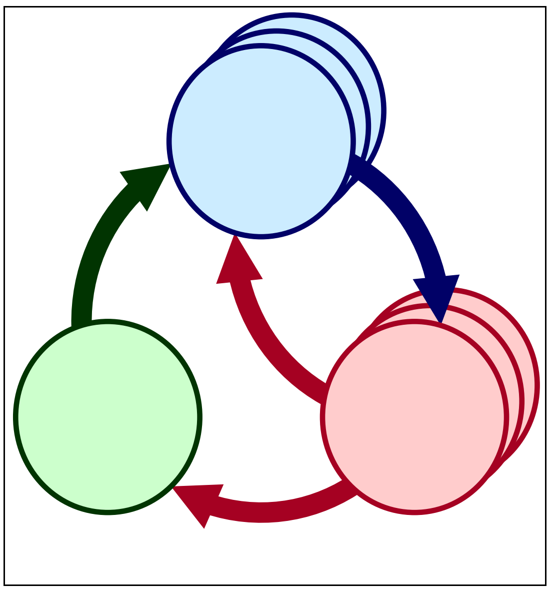

Figure 1: Software Project Management Process Areas Context

The following subordinate sections represent an abbreviated summary of each software project management related Level 2 CMMI™ process area.[1]

Project Planning

The purpose of ***Project Planning*** is to establish and maintain plans that define project activities.

---

[1] Information in each subordinate section was extracted from (CMMI® Product Team 2002). Note that the institutionalization-related goals/practices have been omitted for brevity.

Establish Estimates

Estimate the Scope of the Project

Establish Estimates of Work Product and Task Attributes

Define Project Life Cycle

Determine Estimates of Effort and Cost

Develop a Project Plan

Establish the Budget and Schedule

Identify Project Risks

Plan for Data Management

Plan for Project Resources

Plan for Needed Knowledge and Skills

Plan Stakeholder Involvement

Establish the Project Plan

Obtain Commitment to the Plan

Review Plans that Affect the Project

Reconcile Work and Resource Levels

Obtain Plan Commitment

Project Monitoring and Control

The purpose of ***Project Monitoring and Control*** is to provide an understanding of the project's progress so that appropriate corrective actions can be taken when the project's performance deviates significantly from the plan.

Monitor Project Against Plan

Monitor Project Planning Parameters

Monitor Commitments

Monitor Project Risks

Monitor Data Management

Monitor Stakeholder Involvement

Conduct Progress Reviews

Conduct Milestone Reviews

Manage Corrective Action to Closure

Analyze Issues

Take Corrective Action

Manage Corrective Action

Measurement and Analysis

The purpose of ***Measurement and Analysis*** is to develop and sustain a measurement capability that is used to support management information needs.

Align Measurement and Analysis Activities

Establish Measurement Objectives

Specify Measures

Specify Data Collection and Storage Procedures

Specify Analysis Procedures

Provide Measurement Results

Collect Measurement Data

Analyze Measurement Data

Store Data and Results

Communicate Results

Fundamentals of Software Development

Software Development Taxonomy

Terms defined:[2]

Abstraction – A representation of an idea or concept expressed in a particular medium or language.

Desire – A want or need.

[Software] Requirements – An abstraction of a desire for which computer technology is thought to be a viable solution; the ***essence*** of a software product.

Software – An abstraction of a desire expressed as instructions and data in a form that can be acted upon by a computer.

[2] Term definitions extracted from [4].

Process – A set of actions or operations conducing to an end [3].

Software Development Process – A generalized set of related activities that transform desires into software.

Software [Development] Project – A specific instance of a software development process.

Software Product – The primary (deliverable) result of a Software Development Project; the ***implementation*** of a software product.

Software Development Process Context

Figure 2 depicts the context of a software development process; i.e., how it interfaces with its environment. All instances of software development processes seek to transform software requirements into a software product. To accomplish this transformation, they consume energy in the form of labor (people doing work) from project initiation to project completion. Since no software development process is a *perfect machine*, it produces some amount of waste or entropy (undesired byproducts).

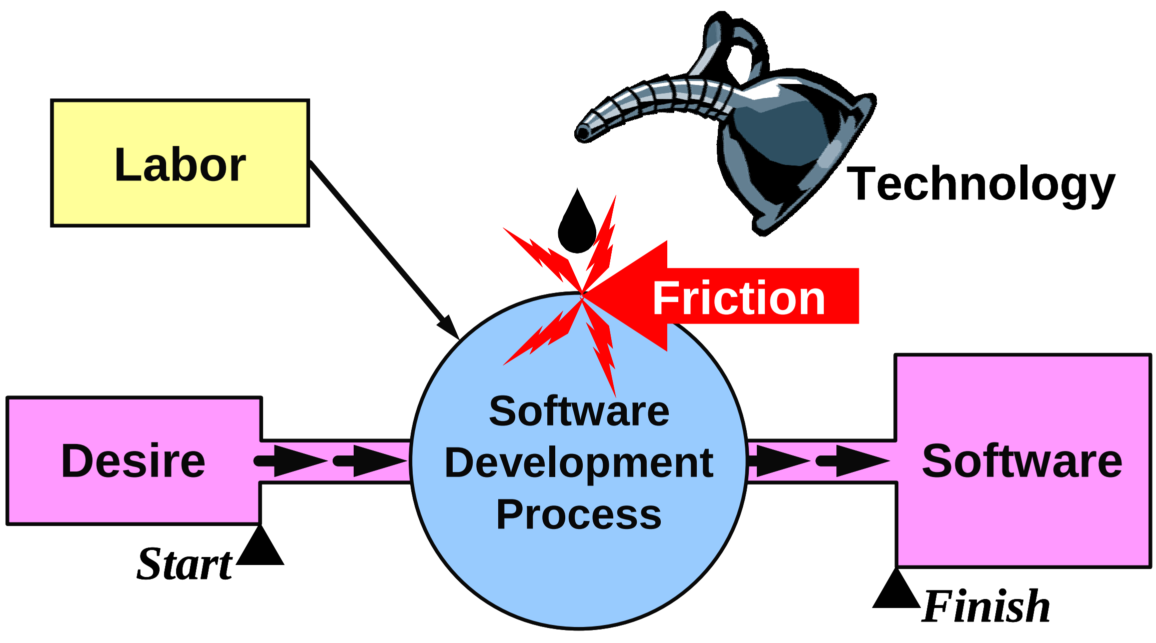

Figure 2: Software Development Context[3]

[3] Figure reprinted with permission from Michael A. ROSS Consulting & Training. All rights reserved.

Measuring the Software Development Process

The key to effectively and efficiently measuring the software development process is to pick measures that quantify the process's connections to its surrounding environment. Just about any core set of software development process measures will include the following:

Size – An abstraction's mass, inertia, bigness (as it directly relates to the work that must be done).

Duration – The elapsed calendar time between process initiation and process completion.

Effort → Cost, Staffing – People doing work during the software development process and their associated cost, over elapsed calendar time.

Quality – Defect discovery and removal over elapsed calendar time.

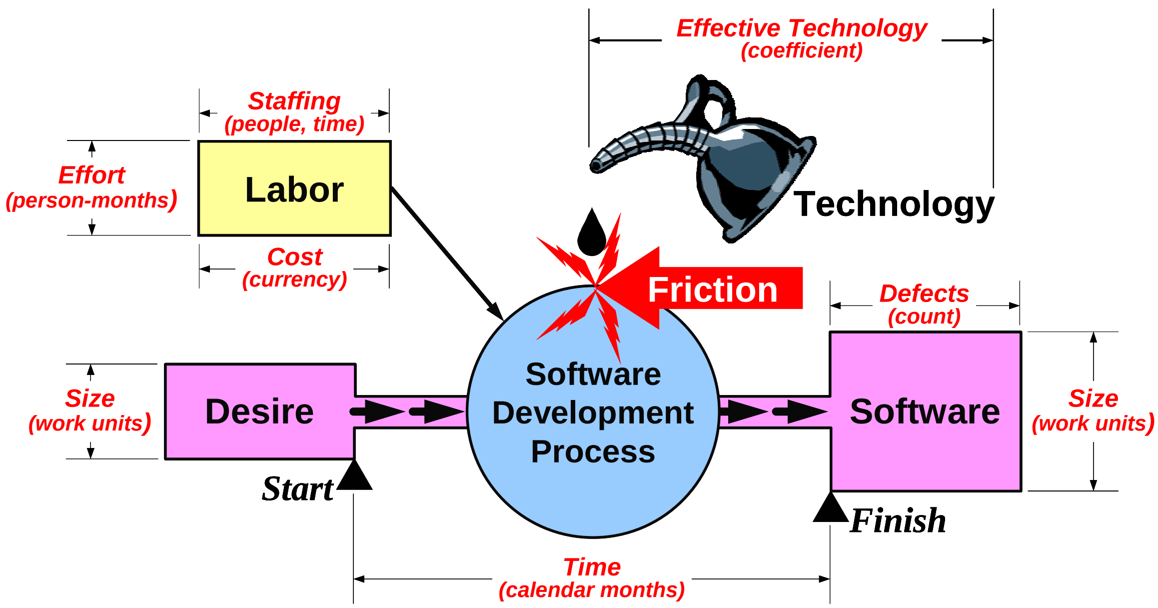

Figure 3: Software Development Process Context with Measurement[4]

A strong indication of the usefulness of these measures is the fact that they address the most frequently asked questions about software development projects:

How big will the product be when delivered?

How long is it going to take?

How many people will be needed and when?

---

[4] Figure reprinted with permission from Michael A. ROSS Consulting & Training. All rights reserved.

How much will it cost?

How reliable will the product be when delivered?

Progress Defined

Transforming Desires to Software

The fundamental goal (i.e., the root of progress) associated with the software development process is the transformation of a mass of knowledge articulated as a desire into a mass of knowledge articulated as software. While this transformation may, in actuality, exist in a space of many dimensions and directions (bordering on chaotic), we choose to focus on a single dimension we will call progress, the axis or direction of which we will call s.

Progress Position and Change

Within dynamic systems, the concept of position is typically used to quantify location within some space relative to some selected reference point. Position is typically represented as a vector quantity; i.e., it consists of both magnitude and direction from some given reference point or point of origin. We have already assumed that our system has only one relevant dimension which we have named progress. Within the progress dimension, we will establish the initial position of the mass of knowledge articulated as a desire (the initial state of the transformation) as being the point of origin of measurement and will measure position relative to this point in the s direction (along the s axis). We will further assume that our system is restricted to the positive side of the s axis; i.e., we will assume the notion of negative position to be undefined.[5]

Normalized Earned Value

Since our system is a transformation from one tangible state (the desire) to another tangible state (the software) with intermediate states being somewhat intangible, we choose unity (1 or 100% complete) to represent the position of the transformation at completion. As previously stated, the initial position of the transformation is assumed to be zero (0% complete). We define any value that represents a specific position on the continuum of intermediate position values as ***normalized earned value***. In other words, if a project's position in the direction of progress is 0.5 (50% complete), then that project's normalized earned value is said to be 0.5 or 50%. If a project has been assigned

[5] The author acknowledges that this assumption is open to challenge; i.e., that it might be necessary to account for the notion of project digression beyond the initial state. The author, however, chooses to take the more positive viewpoint that what appears, on the surface, to be digression, is actually part of the necessary learning process that is key to any development activity. In other words, while it might not be obvious at the time, you are always better off today than you were yesterday.

(estimated to be) some budgeted ***monetary*** value (measured in units of currency) or some budgeted ***effort*** value (measured in units of labor), then the project's earned value may be expressed as the product of its normalized earned value and its total budgeted monetary value or total budgeted effort value respectively.

Closely related to position is the concept of displacement, which is typically used to quantify some change in position. It too is typically represented as a vector quantity. Displacement can be described mathematically as [2]:

$$\mathbf{\Delta r}(t_1, t_2) \equiv \mathbf{r}(t_2) - \mathbf{r}(t_1) \quad \text{Eqn. 1}$$

where:

t_1	Some initial point in time.
t_2	Some final point in time where $t_2 \geq t_1$.
$\mathbf{r}(t_1)$	The initial position vector; the position vector at time t_1.
$\mathbf{r}(t_2)$	The final position vector; the position vector at time t_2.
$\mathbf{\Delta r}(t_1, t_2)$	The displacement vector from the initial position to the final position.

Within the progress dimension s, the magnitude of the displacement vector, $|\mathbf{\Delta r}(t_1, t_2)|$, quantifies a change in normalized earned value from the position at some time t_1 to the position at some later time t_2.

A Review of Performance Measurement Relationships

This section contains a brief definition and description of relevant Performance Measurement relationships. Considering the three forms of earned value introduced in the preceding section (***monetary***, ***effort***, and ***normalized***), we include equations for each of these three unit systems (***currency***, ***labor***, and ***% of BAC***) where meaningful to do so.

Budget at Completion (BAC)

The starting point or anchor measure for Performance Measurement is the ***Budget at Completion (BAC)***. This measure is a primary output of the estimation process and represents what is expected to be spent by the project. The plan that is associated with this value is generally referred to as the ***Baseline Plan*** or simply the ***Baseline***. Note that in the normalized unit system, BAC is always assumed to be unity (1 or 100%). Note also that the currency and labor variants of this value may change during the course of a project as the result of re-planning or re-baselining.

For units of currency:

$$BAC_{\$} \equiv \sum_{i=1}^{n} \text{Activity}_i \text{ Planned Cost} \qquad \textbf{Eqn. 2}$$

Where:

n The total number of activities in the project.

For units of labor:

$$BAC_{L} \equiv \sum_{i=1}^{n} \text{Activity}_i \text{ Planned Effort} \qquad \textbf{Eqn. 3}$$

Where:

n The total number of activities in the project.

For a normalized (% of BAC) measurement system:

$$BAC_{\%} \equiv \left| \Delta\mathbf{r}(t_{start}, t_{finish}) \right| \equiv 1 = 100\% \qquad \textbf{Eqn. 4}$$

Three Fundamental Cost of Work Measures

Performance Measurement requires that, for a given amount of elapsed calendar time t, we know:

How much we've ***planned*** to spend,

How much we've ***earned*** (progressed), and

How much we've actually ***spent***.

Budgeted Cost of Work Scheduled (BCWS)

Value of the work ***planned*** to be done – also known as the Planned Value (PV).

For units of currency:

$$\text{BCWS}_{\$}(t) \equiv \sum_{j=1}^{n} \text{Activity}_j \text{ Planned Cost} \qquad \textbf{Eqn. 5}$$

Where:

Activity_j	Must, in order to count, be planned for completion by time t.
n	Total number of activities in the project.

For units of labor:

$$\text{BCWS}_L(t) \equiv \sum_{j=1}^{n} \text{Activity}_j \text{ Planned Effort} \qquad \textbf{Eqn. 6}$$

Where:

Activity_j	Must, in order to count, be planned for completion by time t.
n	Total number of activities in the project.

For a normalized (% of BAC) measurement system:

$$\text{BCWS}_{\%}(t) \equiv \frac{\text{BCWS}_{\$}(t)}{BAC_{\$}} \equiv \frac{\text{BCWS}_L(t)}{BAC_L} \qquad \textbf{Eqn. 7}$$

Budgeted Cost of Work Performed (BCWP)

Value of the work ***earned*** (accomplished) – also known as the Earned Value (EV).

For units of currency:

$$\text{BCWP}_{\$}(t) \equiv \sum_{l=1}^{m} \text{Completed Activity}_l \text{ Planned Cost} \qquad \textbf{Eqn. 8}$$

Where:

Activity_l	Must, in order to count, be complete by time t.
m	Total number of complete activities in the project.

For units of labor:

$$\text{BCWP}_L(t) \equiv \sum_{l=1}^{m} \text{Completed Activity}_l \text{ Planned Effort} \qquad \textbf{Eqn. 9}$$

Where:

Activity_l	Must, in order to count, be complete by time t.
m	Total number of complete activities in the project.

For a normalized (% of BAC) measurement system:

$$\mathrm{BCWP}_{\%}(t) \equiv |\mathbf{\Delta r}(0,t)| \equiv \frac{\mathrm{BCWP}_{\$}(t)}{BAC_{\$}} \equiv \frac{\mathrm{BCWP}_{L}(t)}{BAC_{L}} \qquad \textbf{Eqn. 10}$$

Actual Cost of Work Performed (ACWP)

Actual amount ***spent*** to accomplish the work – Actual Cost (AC).

For units of currency:

$$\mathrm{ACWP}_{\$}(t) \equiv \sum_{k=1}^{n} \mathrm{Activity}_k \text{ Actual Accumulated Cost} \qquad \textbf{Eqn. 11}$$

Where:

n Total number of activities in the project.

For units of labor:

$$\mathrm{ACWP}_{L}(t) \equiv \sum_{k=1}^{n} \mathrm{Activity}_k \text{ Actual Accumulated Effort} \qquad \textbf{Eqn. 12}$$

Where:

n Total number of activities in the project.

For a normalized (% of BAC) measurement system:

$$\mathrm{ACWP}_{\%}(t) \equiv \frac{\mathrm{ACWP}_{\$}(t)}{BAC_{\$}} \equiv \frac{\mathrm{ACWP}_{L}(t)}{BAC_{L}} \qquad \textbf{Eqn. 13}$$

Fundamental Variances

Cost Variance (CV)

Difference between earned and spent. Positive values are favorable, negative values are unfavorable.

For units of currency:

$$\mathrm{CV}_{\$}(t) \equiv \mathrm{BCWP}_{\$}(t) - \mathrm{ACWP}_{\$}(t) \qquad \textbf{Eqn. 14}$$

For units of labor:

$$\mathrm{CV}_L(t) \equiv \mathrm{BCWP}_L(t) - \mathrm{ACWP}_L(t) \qquad \textbf{Eqn. 15}$$

For a normalized (% of BAC) measurement system:

$$\mathrm{CV}_{\%}(t) \equiv \mathrm{BCWP}_{\%}(t) - \mathrm{ACWP}_{\%}(t) \qquad \textbf{Eqn. 16}$$

Schedule Variance (SV)

Difference between earned and planned. Positive values are favorable, negative values are unfavorable.

For units of currency:

$$\mathrm{SV}_{\$}(t) \equiv \mathrm{BCWP}_{\$}(t) - \mathrm{BCWS}_{\$}(t) \qquad \textbf{Eqn. 17}$$

For units of labor:

$$\mathrm{SV}_L(t) \equiv \mathrm{BCWP}_L(t) - \mathrm{BCWS}_L(t) \qquad \textbf{Eqn. 18}$$

For a normalized (% of BAC) measurement system:

$$\mathrm{SV}_{\%}(t) \equiv \mathrm{BCWP}_{\%}(t) - \mathrm{BCWS}_{\%}(t) \qquad \textbf{Eqn. 19}$$

Additional Variances

Budget Variance (BV)

Difference between planned and actual. Positive values are favorable, negative values are unfavorable.

For units of currency:

$$\mathrm{BV}_{\$}(t) \equiv \mathrm{BCWS}_{\$}(t) - \mathrm{ACWP}_{\$}(t) \qquad \textbf{Eqn. 20}$$

For units of labor:

$$\mathrm{BV}_L(t) \equiv \mathrm{BCWS}_L(t) - \mathrm{ACWP}_L(t) \qquad \textbf{Eqn. 21}$$

For a normalized (% of BAC) measurement system:

$$\mathrm{BV}_{\%}(t) \equiv \mathrm{BCWS}_{\%}(t) - \mathrm{ACWP}_{\%}(t) \qquad \textbf{Eqn. 22}$$

Time Variance (TV)

Difference in elapsed calendar time between time now and time where plan function equals earned function evaluated at time now. Positive values are favorable, negative values are unfavorable.

For units of elapsed calendar time:

$$\mathrm{TV}_t(t) \equiv t_{\mathrm{BCWS}_\$=\mathrm{BCWP}_\$(t)} - t \equiv t_{\mathrm{BCWS}_L=\mathrm{BCWP}_L(t)} - t \equiv t_{\mathrm{BCWS}_{\%}=\mathrm{BCWP}_{\%}(t)} - t \qquad \textbf{Eqn. 23}$$

For a normalized (% of BAC) measurement system:

$$\mathrm{TV}_{\%}(t) \equiv \frac{t_{\mathrm{BCWS}_\$=\mathrm{BCWP}_\$(t)} - t}{t_{\mathrm{BCWS}_\$=\mathrm{BCWP}_\$(t)}} \equiv \frac{t_{\mathrm{BCWS}_L=\mathrm{BCWP}_L(t)} - t}{t_{\mathrm{BCWS}_L=\mathrm{BCWP}_L(t)}} \equiv \frac{t_{\mathrm{BCWS}_{\%}=\mathrm{BCWP}_{\%}(t)} - t}{t_{\mathrm{BCWS}_{\%}=\mathrm{BCWP}_{\%}(t)}} \qquad \textbf{Eqn. 24}$$

Fundamental Performance Indices

Cost Performance Index (CPI)

Amount earned to amount spent ratio; cost efficiency achieved from project start to time t. Values greater than unity are favorable, values less than unity are unfavorable.

$$\mathrm{CPI}(t) \equiv \frac{\mathrm{BCWP}_\$(t)}{\mathrm{ACWP}_\$(t)} \equiv \frac{\mathrm{BCWP}_L(t)}{\mathrm{ACWP}_L(t)} \equiv \frac{\mathrm{BCWP}_{\%}(t)}{\mathrm{ACWP}_{\%}(t)} \qquad \textbf{Eqn. 25}$$

Schedule Performance Index (SPI)

Amount earned to amount planned ratio; schedule efficiency achieved from project start to time t. Values greater than unity are favorable, values less than unity are unfavorable.

$$\mathrm{SPI}(t) \equiv \frac{\mathrm{BCWP}_{\$}(t)}{\mathrm{BCWS}_{\$}(t)} \equiv \frac{\mathrm{BCWP}_{L}(t)}{\mathrm{BCWS}_{L}(t)} \equiv \frac{\mathrm{BCWP}_{\%}(t)}{\mathrm{BCWS}_{\%}(t)} \quad \textbf{Eqn. 26}$$

Additional Performance Indices

Budget Performance Index (BPI)

Amount planned to amount spent ratio; budget efficiency achieved from project start to time t. Values greater than unity are favorable, values less than unity are unfavorable.

$$\mathrm{BPI}(t) \equiv \frac{\mathrm{BCWS}_{\$}(t)}{\mathrm{ACWP}_{\$}(t)} \equiv \frac{\mathrm{BCWS}_{L}(t)}{\mathrm{ACWP}_{L}(t)} \equiv \frac{\mathrm{BCWS}_{\%}(t)}{\mathrm{ACWP}_{\%}(t)} \quad \textbf{Eqn. 27}$$

Time Performance Index (TPI)

Time efficiency achieved from project start to time t. Values greater than unity are favorable, values less than unity are unfavorable.

$$\mathrm{TPI}(t) \equiv \frac{t_{\mathrm{BCWS}_{\$}=\mathrm{BCWP}_{\$}(t)}}{t} \equiv \frac{t_{\mathrm{BCWS}_{L}=\mathrm{BCWP}_{L}(t)}}{t} \equiv \frac{t_{\mathrm{BCWS}_{\%}=\mathrm{BCWP}_{\%}(t)}}{t} \quad \textbf{Eqn. 28}$$

Composite Performance Index (XPI)

Combined cost and schedule efficiency achieved from project start to time t. Values greater than unity are favorable, values less than unity are unfavorable.

$$\mathrm{XPI}(t) \equiv \sqrt{\mathrm{CPI}(t)\mathrm{SPI}(t)} \quad \textbf{Eqn. 29}$$

Status and Forecasting Metrics

Percent Complete

$$\text{Percent Complete} \equiv \mathrm{BCWP}_{\%} \quad \textbf{Eqn. 30}$$

Percent Spent

$$\text{Percent Spent} \equiv \text{ACWP}_{\%} \qquad \textbf{Eqn. 31}$$

Estimate at Completion (EAC)

Expected (predicted) actual cost value when normalized earned value reaches 100%.

EAC Based on Cost Variance (Basic)

For units of currency:

$$\text{EACbasic}_{\$}(t) \equiv BAC_{\$} - \text{CV}_{\$}(t) \qquad \textbf{Eqn. 32}$$

For units of labor:

$$\text{EACbasic}_{L}(t) \equiv BAC_{L} - \text{CV}_{L}(t) \qquad \textbf{Eqn. 33}$$

For a normalized (% of BAC) measurement system:

$$\text{EACbasic}_{\%}(t) \equiv BAC_{\%} - \text{CV}_{\%}(t) \qquad \textbf{Eqn. 34}$$

EAC Based on Cost Performance

For units of currency:

$$\text{EACcpi}_{\$}(t) \equiv \frac{BAC_{\$}}{\text{CPI}(t)} \qquad \textbf{Eqn. 35}$$

For units of labor:

$$\text{EACcpi}_{L}(t) \equiv \frac{BAC_{L}}{\text{CPI}(t)} \qquad \textbf{Eqn. 36}$$

For a normalized (% of BAC) measurement system:

$$\text{EACcpi}_{\%}(t) \equiv \frac{BAC_{\%}}{\text{CPI}(t)} \qquad \textbf{Eqn. 37}$$

EAC Based on Composite Performance

For units of currency:

$$\text{EAC xpi}_{\$}\left(t\right) \equiv \frac{BAC_{\$}}{\text{XPI}\left(t\right)} \qquad \textbf{Eqn. 38}$$

For units of labor:

$$\text{EAC xpi}_{L}\left(t\right) \equiv \frac{BAC_{L}}{\text{XPI}\left(t\right)} \qquad \textbf{Eqn. 39}$$

For a normalized (% of BAC) measurement system:

$$\text{EAC xpi}_{\%}\left(t\right) \equiv \frac{BAC_{\%}}{\text{XPI}\left(t\right)} \qquad \textbf{Eqn. 40}$$

Estimate to Complete (ETC)

The expected additional work that must be done to achieve a normalized earned value of 100%.

For units of currency:

$$\text{ETC}_{\$}\left(t\right) \equiv BAC_{\$} - \text{BCWP}_{\$}\left(t\right) \qquad \textbf{Eqn. 41}$$

For units of labor:

$$\text{ETC}_{L}\left(t\right) \equiv BAC_{L} - \text{BCWP}_{L}\left(t\right) \qquad \textbf{Eqn. 42}$$

For a normalized (% of BAC) measurement system:

$$\text{ETC}_{\%}\left(t\right) \equiv BAC_{\%} - \text{BCWP}_{\%}\left(t\right) = 100\% - \text{BCWP}_{\%}\left(t\right) \qquad \textbf{Eqn. 43}$$

Variance at Completion (VAC)

Difference between planned and predicted. Positive values are favorable, negative values are unfavorable.

VAC Based on Cost Performance

For units of currency:

$$\text{VACcpi}_{\$}\left(t\right) \equiv BAC_{\$} - \text{EACcpi}_{\$}\left(t\right) \qquad \textbf{Eqn. 44}$$

For units of labor:

$$\text{VACcpi}_{L}\left(t\right) \equiv BAC_{L} - \text{EACcpi}_{L}\left(t\right) \qquad \textbf{Eqn. 45}$$

For a normalized (% of BAC) measurement system:

$$\text{VACcpi}_{\%}\left(t\right) \equiv BAC_{\%} - \text{EACcpi}_{\%}\left(t\right) \qquad \textbf{Eqn. 46}$$

VAC Based on Composite Performance

For units of currency:

$$\text{VACxpi}_{\$}\left(t\right) \equiv BAC_{\$} - \text{EACxpi}_{\$}\left(t\right) \qquad \textbf{Eqn. 47}$$

For units of labor:

$$\text{VACxpi}_{L}\left(t\right) \equiv BAC_{L} - \text{EACxpi}_{L}\left(t\right) \qquad \textbf{Eqn. 48}$$

For a normalized (% of BAC) measurement system:

$$\text{VACxpi}_{\%}\left(t\right) \equiv BAC_{\%} - \text{EACxpi}_{\%}\left(t\right) \qquad \textbf{Eqn. 49}$$

To Complete Performance Index (TCPI)

Ratio of work remaining against money remaining (efficiency which must be achieved to complete the remaining work with the expected remaining money).

TCPI Based on Cost Variance (Basic)

$$\mathrm{TCPIbasic}(t) \equiv \frac{\text{Work Remaining}}{\text{Cost Remaining}} \equiv \frac{BAC_{\$} - \mathrm{BCWP}_{\$}(t)}{\mathrm{EACbasic}_{\$}(t) - \mathrm{ACWP}_{\$}(t)} \equiv \frac{BAC_{L} - \mathrm{BCWP}_{L}(t)}{\mathrm{EACbasic}_{L}(t) - \mathrm{ACWP}_{L}(t)} \equiv \frac{BAC_{\%} - \mathrm{BCWP}_{\%}(t)}{\mathrm{EACbasic}_{\%}(t) - \mathrm{ACWP}_{\%}(t)} \quad \textbf{Eqn. 50}$$

TCPI Based on Cost Performance

$$\mathrm{TCPIcp}(t) \equiv \frac{\text{Work Remaining}}{\text{Cost Remaining}} \equiv \frac{BAC_{\$} - \mathrm{BCWP}_{\$}(t)}{\mathrm{EACcpi}_{\$}(t) - \mathrm{ACWP}_{\$}(t)} \equiv \frac{BAC_{L} - \mathrm{BCWP}_{L}(t)}{\mathrm{EACcpi}_{L}(t) - \mathrm{ACWP}_{L}(t)} \equiv \frac{BAC_{\%} - \mathrm{BCWP}_{\%}(t)}{\mathrm{EACcpi}_{\%}(t) - \mathrm{ACWP}_{\%}(t)} \quad \textbf{Eqn. 51}$$

TCPI Based on Composite Performance

$$\mathrm{TCPIxp}(t) \equiv \frac{\text{Work Remaining}}{\text{Cost Remaining}} \equiv \frac{BAC_{\$} - \mathrm{BCWP}_{\$}(t)}{\mathrm{EACxpi}_{\$}(t) - \mathrm{ACWP}_{\$}(t)} \equiv \frac{BAC_{L} - \mathrm{BCWP}_{L}(t)}{\mathrm{EACxpi}_{L}(t) - \mathrm{ACWP}_{L}(t)} \equiv \frac{BAC_{\%} - \mathrm{BCWP}_{\%}(t)}{\mathrm{EACxpi}_{\%}(t) - \mathrm{ACWP}_{\%}(t)} \quad \textbf{Eqn. 52}$$

Average Performance

Average of work accomplished on the project from the actual start time t_{A_start}, defined as the earliest time t' where $\mathrm{ACWP}_{\%}(t') > 0$, to time t.

For units of currency:

$$\overline{\mathrm{PA}_{\$}}(t) \equiv \frac{\mathrm{BCWP}_{\$}(t)}{t - t_{A\_start}} \quad \textbf{Eqn. 53}$$

For units of labor:

$$\overline{\mathrm{PA}_L}(t) \equiv \frac{\mathrm{BCWP}_\$(t)}{t - t_{A\_start}} \quad \textbf{Eqn. 54}$$

For a normalized (% of BAC) measurement system:

$$\overline{\mathrm{PA}_\%}(t) \equiv \frac{\mathrm{BCWP}_\%(t)}{t - t_{A\_start}} \quad \textbf{Eqn. 55}$$

Average Expected Performance to Finish

Average of the work which must be accomplished to complete the project at the baseline finish time t_{BL_finish}, defined as the earliest time t' where $\mathrm{BCWS}_\%(t') = 1 = 100\%$.

For units of currency:

$$\overline{\mathrm{PE}_\$}(t) \equiv \frac{BAC_\$ - \mathrm{BCWP}_\$(t)}{t_{BL\_finish} - t} \quad \textbf{Eqn. 56}$$

For units of labor:

$$\overline{\mathrm{PE}_L}(t) \equiv \frac{BAC_L - \mathrm{BCWP}_L(t)}{t_{BL\_finish} - t} \quad \textbf{Eqn. 57}$$

For a normalized (% of BAC) measurement system:

$$\overline{\mathrm{PE}_\%}(t) \equiv \frac{BAC_\% - \mathrm{BCWP}_\%(t)}{t_{BL\_finish} - t} \quad \textbf{Eqn. 58}$$

Parametric Project Monitoring and Control (PPMC)

PPMC Vision

For at least the last two decades, software development projects have benefited from various time-proven techniques for estimating the duration and effort of software

development projects. Unfortunately for most projects, the estimation process occurs only once, at the beginning of the project, at a time when the least is known about what the project should be. In the very worst of cases, when a project subsequently gets into trouble, the trouble goes unnoticed until the inevitable late delivery with associated cost overrun. This open-loop process behavior is illustrated in Figure 4 below.

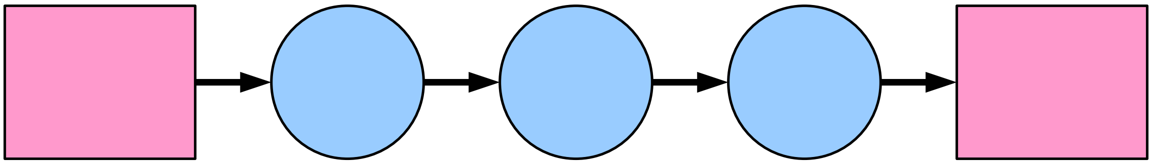

Figure 4: No Project Control

The typical first step in trying to get projects under control is the introduction of a measurement and metrics process (e.g., Performance Measurement) which, by itself, supports a minimal although ad-hoc project control capability as shown in Figure 5 below.

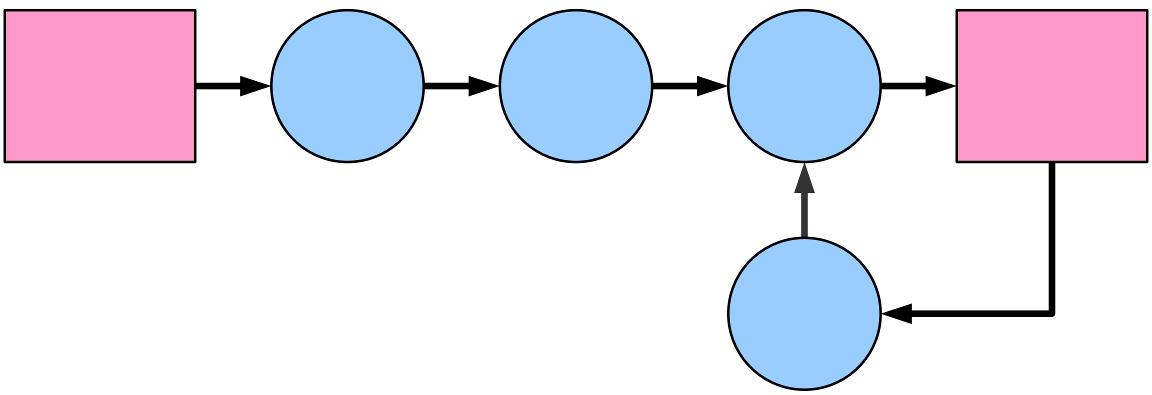

Figure 5: Ad-hoc Project Control

Next, and what represents the current status quo, is the introduction of tools that schedule tasks and allocate resources as some function of inter-task dependencies, resource availability, and priority. These tools can accept measures from a Performance Measurement process and make any necessary schedule adjustments. The typical strategy is to re-baseline the project by identifying all of the incomplete tasks in the project plan as a subproject and slipping the schedule of the entire subproject (as a whole) to begin on the current date t_{now} (see Figure 6 below).

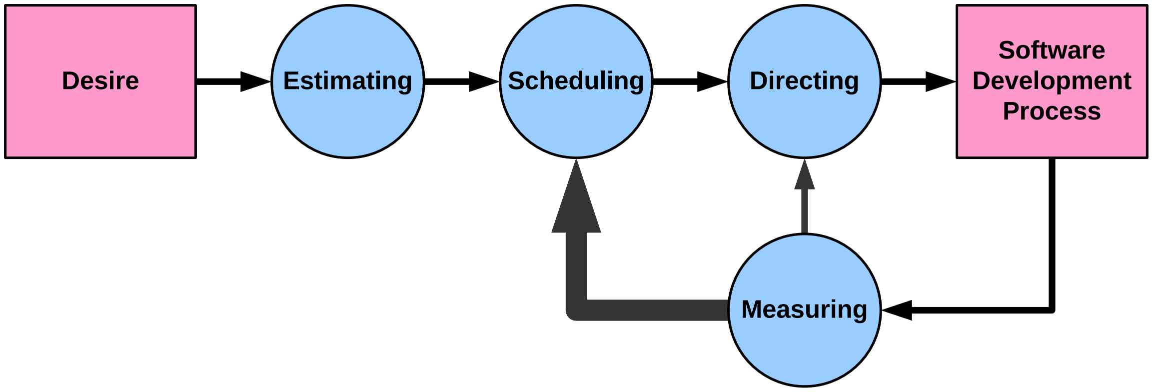

Figure 6: Partial Project Control

The problem with this strategy is that it does not take into account that which may be causing the project to be in trouble in the first place; namely that expected performance (efficiency or productivity) is not matching actual performance. Instead, we are perpetuating a possibly erroneous assumption about performance which may come back to bite us again. We therefore propose including established estimation methodology and algorithms as part of the prediction and re-baselining activities performed during the Project Monitoring and Control process and refer to this process as Parametric Project Monitoring and Control (PPMC). The idea is to extend the scope of software development project estimation to include situations where the project is already under way and where some project actuals already exist.[6]

In order to realize the vision of PPMC, we propose including estimation in the project monitoring and control loop (see Figure 7 below).

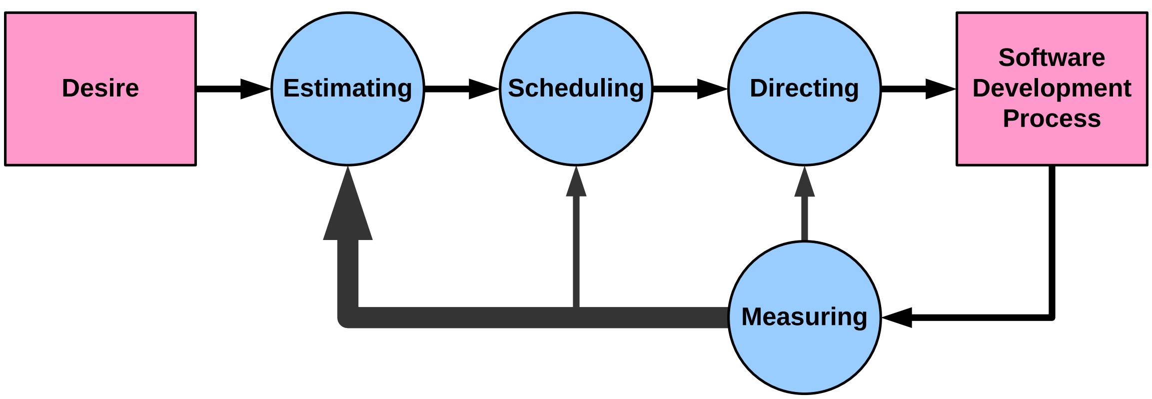

Figure 7: Full Project Control

[6] It is important to note that PPMC is not intended as a replacement for but rather as complementary to the Earned Value Management (EVM) process.

Extending the Notion of Quantifying Progress (Earning Value)

Within the realm of Performance Measurement, one criticism that routinely surfaces is the sometimes arbitrary manner in which progress or value (percent complete) is credited to activities within a project or to the project as a whole. The result of this arbitrariness is sometimes referred to as the "90% complete 90% of the time" syndrome. This paper proposes a four-dimensional (4-D) approach for assigning progress to the development of each program/application (Computer Software Configuration Item (CSCI)) that is part of the project. The first dimension is ***Software Development Life Cycle (SDLC) primary activity completion*** for the development of a specific program/application (CSCI). Each SDLC primary activity[7], in turn, is assigned progress according to a weighted combination of three other dimensions: ***artifact completion***, ***milestone completion***, and ***defect discovery / removal***.

Program/Application (CSCI) Progress

$\mathrm{BCWP}_{\%}(t)$ for each program/application (CSCI) is computed as the normalized weighted sum of the applicable SDLC primary activities' completion percentage. The weighting scheme is directly derived from the effort-to-activity allocation defined in the project's baseline plan.

SDLC Primary Activity Completion

During the project monitoring and control process, the completion percentage for each SDLC primary activity is computed as the normalized weighted sum of its artifacts completed, its milestones completed, and its associated number of defects discovered and defects removed.

Artifact Completion

As part of the project planning process, a list of artifact types is identified and each type is assigned to the appropriate SDLC primary activity. Each artifact type is weighted according to its relative contribution to the completion of its associated primary activity. Additionally, as part of the project planning process, the total number of artifacts of each type is estimated for each program/application (CSCI). These totals are used to determine the relative weighted contribution of each completed artifact to the completion of its associated SDLC primary activity.

During the project monitoring and control process, the total number of completed artifacts of each type are periodically and/or aperiodically measured and recorded.

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[7] An example of a set of SDLC primary activities is System Requirements Design, Software Requirements Analysis, Preliminary Design, Detailed Design, Code & Unit Test, Component Integration & Test, Program Test, System Integration thru Operational Test & Evaluation. There are various SDLCs, each with its own unique set of primary activities.

Milestone Completion

As part of the project planning process, a list of milestones (events) is identified and each is assigned to the appropriate SDLC primary activity. Each milestone is weighted according to its relative contribution to the completion of its associated primary activity.

During the project monitoring and control process, milestone completion state is periodically/aperiodically determined and recorded.

Defect Discovery / Removal

As part of the project planning process, an estimate is made for each program/application (CSCI) of its total theoretical number defects. This body of defects is then twice distributed over elapsed calendar time; once according discovery and once according to removal. The body of defects is also proportionally distributed across the set of SDLC primary activities according to each activity's corresponding effort allocation. The total number of defects allocated to each SDLC primary activity is used to determine the relative weighted contribution of each discovered and removed defect to the completion of its associated SDLC primary activity.

During the PPMC process, the total numbers of discovered and of removed defects for each SDLC primary activity are periodically/aperiodically measured and recorded.

At-a-Glance Status Indication of Measures and Metrics

The traffic signal metaphor has become a fairly commonplace strategy to indicate Work Breakdown Structure (WBS) individual task status (red, yellow, green). Since status can be tracked as a function of elapsed calendar time, the notion of status is often-times supplemented by the inclusion of status trend (better, no change, worse). We propose to extend this strategy to include several measures and metrics associated with each program/application (CSCI) that are managed as part of PPMC. These measures and metrics include:[8]

Cost Variance and Cost Performance Index

Schedule Variance and Schedule Performance Index

Budget Variance and Budget Performance Index

Time Variance and Time Performance Index

Size Growth [4]

Size Uncertainty Convergence [4]

Defect Discovery Variance

Defect Removal Variance

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[8] This is an evolving list of measures and metrics and is expected to grow as experience is gained applying PPMC to real projects.

Control Limits

Earlier in this paper we defined success to mean achieving or exceeding expectations and asserted that success occurs when the actual outcome matches, ***within a reasonable tolerance***, the expected outcome. In the preceding section we proposed quantifying measurement and metric status using the traffic signal metaphor with trend supplement. In order to realize the traffic signal metaphor for a given measure or metric, we must define all the transitions between green and yellow and between yellow and red. We propose to call these transitions ***control limits*** and include them as part of our PPMC process in order to link the notion of reasonable tolerance to the notion of status.

We now propose the following definition for the set of control limits associated with a particular measure or metric where the particular measure or metric can be expressed as a function of elapsed calendar time:[9]

$$\begin{array}{ll} control\_limit\_set \equiv & upper\_yellow\_to\_red\_control\_limit \\ & upper\_green\_to\_yellow\_control\_limit \\ & lower\_green\_to\_yellow\_control\_limit \\ & lower\_yellow\_to\_red\_control\_limit \end{array} \quad \text{Eqn. 59}$$

$$\begin{array}{ll} upper\_yellow\_to\_red\_control\_limit \equiv & control\_limit\_segment \\ & [control\_limit\_segment]\ldots \end{array} \quad \text{Eqn. 60}$$

$$\begin{array}{ll} upper\_green\_to\_yellow\_control\_limit \equiv & control\_limit\_segment \\ & [control\_limit\_segment]\ldots \end{array} \quad \text{Eqn. 61}$$

$$\begin{array}{ll} upper\_yellow\_to\_red\_control\_limit \equiv & control\_limit\_segment \\ & [control\_limit\_segment]\ldots \end{array} \quad \text{Eqn. 62}$$

$$\begin{array}{ll} upper\_yellow\_to\_red\_control\_limit \equiv & control\_limit\_segment \\ & [control\_limit\_segment]\ldots \end{array} \quad \text{Eqn. 63}$$

$$\begin{array}{ll} control\_limit\_segment \equiv & starting\_month\_number \\ & scale\_factor \\ & offset \end{array} \quad \text{Eqn. 64}$$

Note that $starting\_month\_number = 0$ indicates both a null $control\_limit\_segment$ and the last $control\_limit\_segment$ in a list.

The $control\_limit\_segment$ function $u_j(t_i)$ for the j^{th} $control\_limit\_segment$ of a particular $control\_limit$ in a $control\_limit\_set$ associated with a particular measure or metric that is

[9] The author acknowledges that the “perfect” control limit schema would allow specification as any function of elapsed calendar time. The proposed schema represents a compromise between flexibility and computational complexity.

a function of elapsed calendar time $\mathrm{m}(t_i)$ and evaluated at the i^{th} month into the project is defined as:

$$\mathrm{u}_j(t_i) = (a_j)\mathrm{m}(t_i) + b_j \qquad \textbf{Eqn. 65}$$

Where:

m	One more than the count of whole months in the range t_{start} to t_{finish} where $m \in \text{¥}$.
n	The count of control limit segments in a particular control limit where $n \in \text{¥}$.
i	Month number where $i \in \text{¥} \cap [1, m]$.
j	Control limit segment index where $j \in \text{¢}^* \cap [0, n]$
t_i	Quantum elapsed calendar time from t_{start} to i months into the project.
a_j	Scale factor of the j^{th} control limit segment.
b_j	Offset of the j^{th} control limit segment; must be scaled in the same units as is $\mathrm{m}(t_i)$.
$\mathrm{m}(t_i)$	A particular measure or metric defined as a function of elapsed calendar time t_i.
$\mathrm{u}_j(t_i)$	j^{th} control limit segment value for a particular control limit as a function of elapsed calendar time t_i.

Performance-Based Forecasting and Re-Baselining

At the heart of the PPMC vision is the desire to forecast the final project outcome. We have already proposed the idea of including the estimation process and all of its algorithmic strength in the forecasting process. The question now becomes, “How can we do that?” The following subordinate sections contain a set of process steps that support the creation of a new project plan (estimate) that, by its nature, represents a performance-based forecast and, therefore, represents a reasonable new baseline plan (re-baseline). A strategic goal of PPMC is to eventually automate as many steps in this process as are reasonably possible.

Step 1: Start a New Estimate

Use the current baseline as the starting point for a new estimate.

Step 2: Update Size Estimate

Revisit all of the assumptions (Basis of Estimate) associated with the current estimate of and uncertainty around software size. Include other sizing techniques, if appropriate, in order to improve sizing accuracy. Make changes where appropriate.

Step 3: Update Technology Assumptions

Revisit all Knowledge Base and technology parameter assumptions that formed the Basis of Estimate for the current baseline. Align Knowledge Base selections and technology parameter settings with what has actually happened to date on the project. Make changes where appropriate.

Step 4: Update Schedule Assumptions

Revisit the project start date and any assumptions about the time-effort tradeoff solution (i.e., minimum time versus optimal effort, schedule constraints, etc.). Make any changes where appropriate.

Step 5: Update Staffing Assumptions

Specify staffing constraints from project start to time now that match (as close as possible) the actual staffing profile to date. Revisit future staffing assumptions from time now and make adjustments where appropriate.

Step 6: Update Labor Rate and FTE Assumptions

Revisit all labor rates as well as the definition of a Full Time Equivalent person (typically specified as number of labor-hours per labor-month). Make any changes where appropriate.

Step 7: Time Now Calibration

This step assumes that the estimation model or process being used can be calibrated by making adjustments to one or more calibration coefficients. We propose iteratively adjusting each calibration coefficient with the goal of creating a plan that corresponds with actual performance (BCWP) and actual expenditure (ACWP) to date. We propose a reasonable test for this correspondence to be performance indices (BPI, CPI, SPI, TPI) approaching unity. Practically speaking, we are creating a new plan that matches

what has already happened and uses established estimation relationships to predict what is likely to happen from time now considering what has already happened up to time now.

Step 8: Communicate the Results

Use an appropriate set of charts and reports to present the results of the forecasting process. A chart that is particularly useful for this purpose is of the type shown in Figure 8.

Step 9: Re-Baseline the Project

If warranted by project expectations, goals, and commitments and upon approval by appropriate authority, replace the current baseline with the current (new) estimate and track against this new baseline.

Communicating Performance Measurement Information

PPMC Outputs

One of the primary goals of PPMC is to provide adequate supporting documentation (charts and reports) to support the software project management process and to satisfy stakeholder needs. Figure 8 through Figure 14 show prototypical examples of charts and reports that can be used for such a purpose.

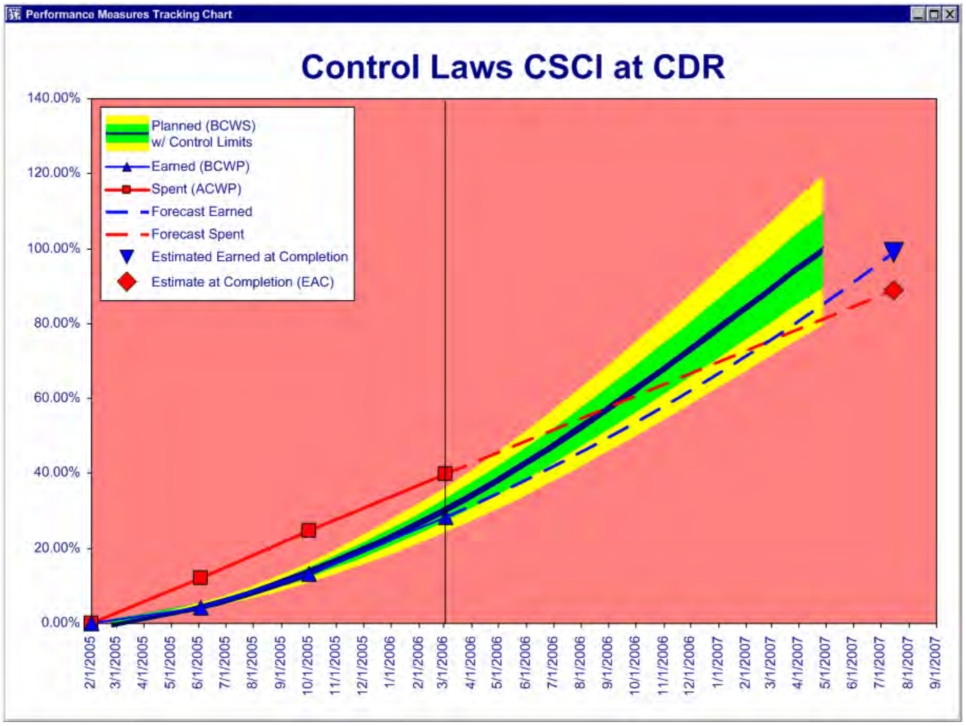

Figure 8: Prototype Performance Measures Tracking Chart

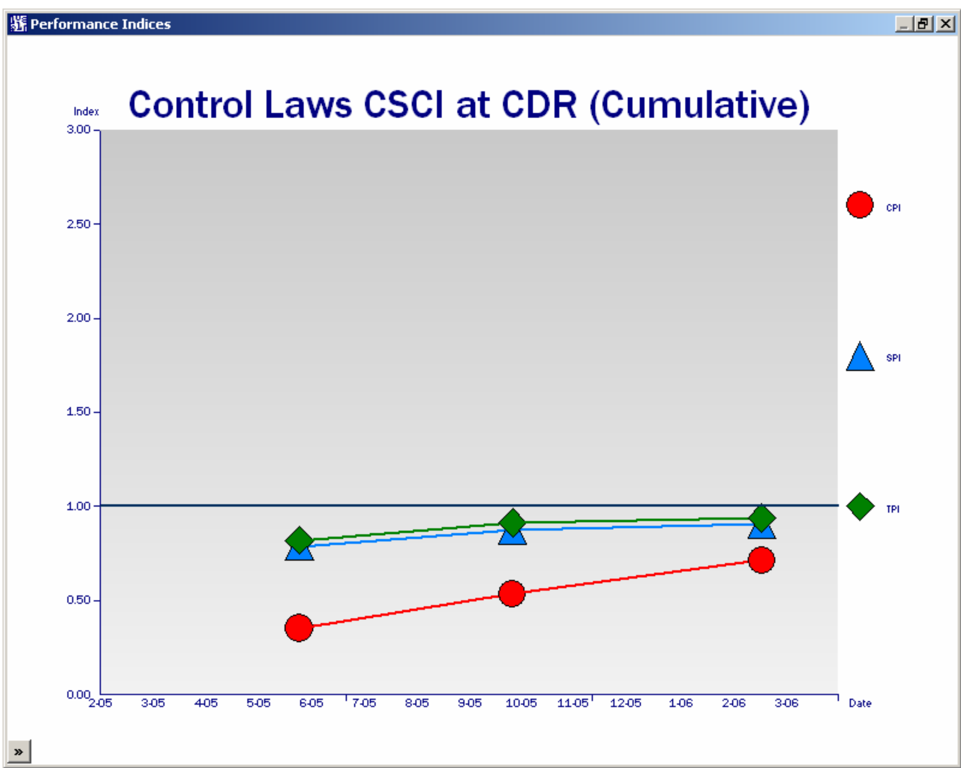

Figure 9: Prototype Performance Indices Tracking Chart

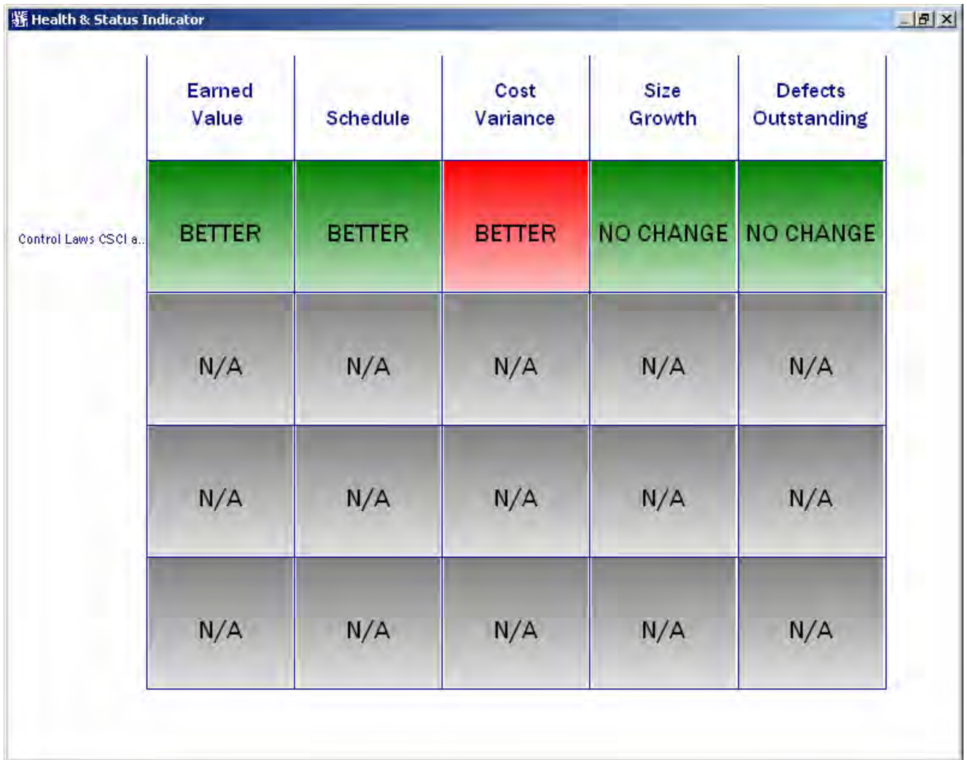

Figure 10: Prototype Status Indicators Chart

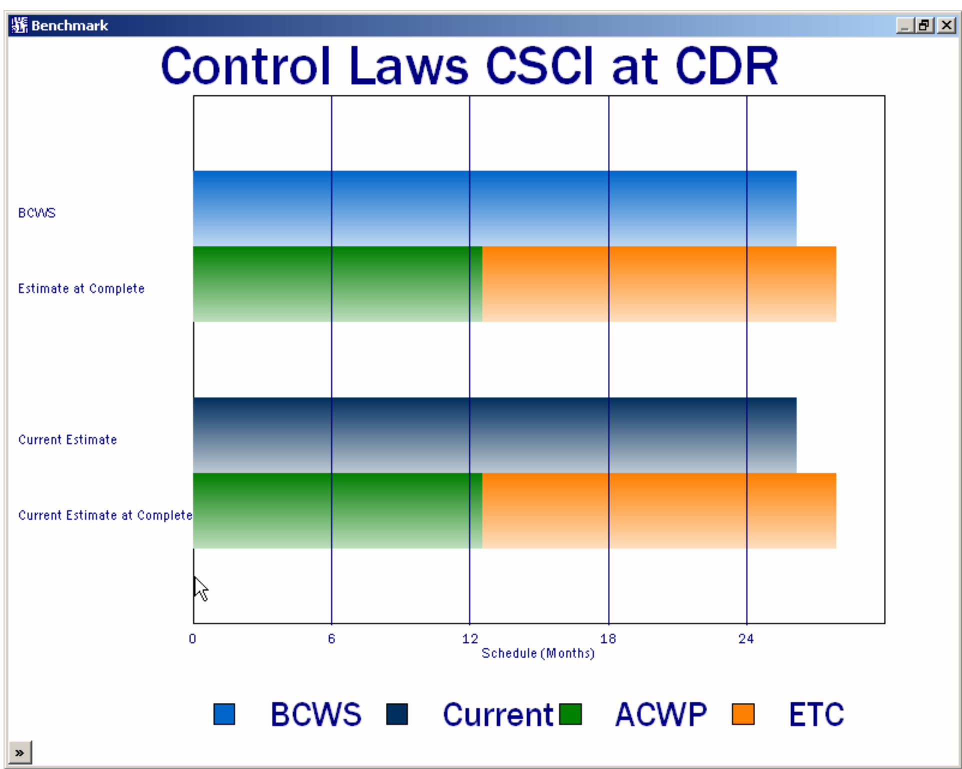

Figure 11: Prototype Schedule Plan versus Prediction Chart

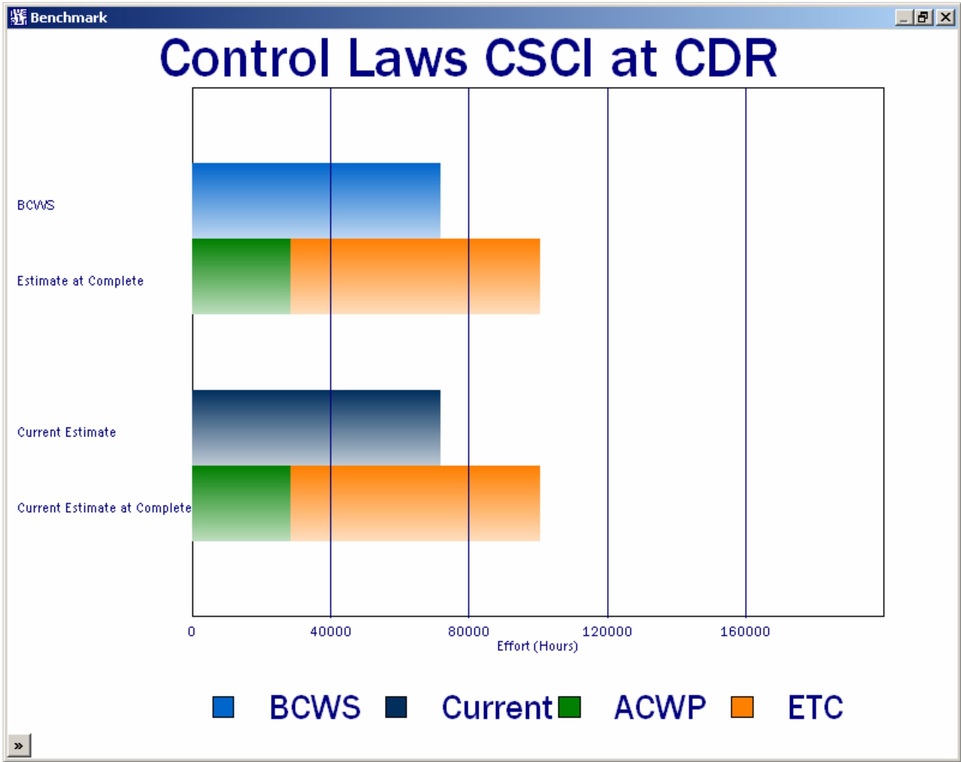

Figure 12: Prototype Effort Plan versus Prediction Chart

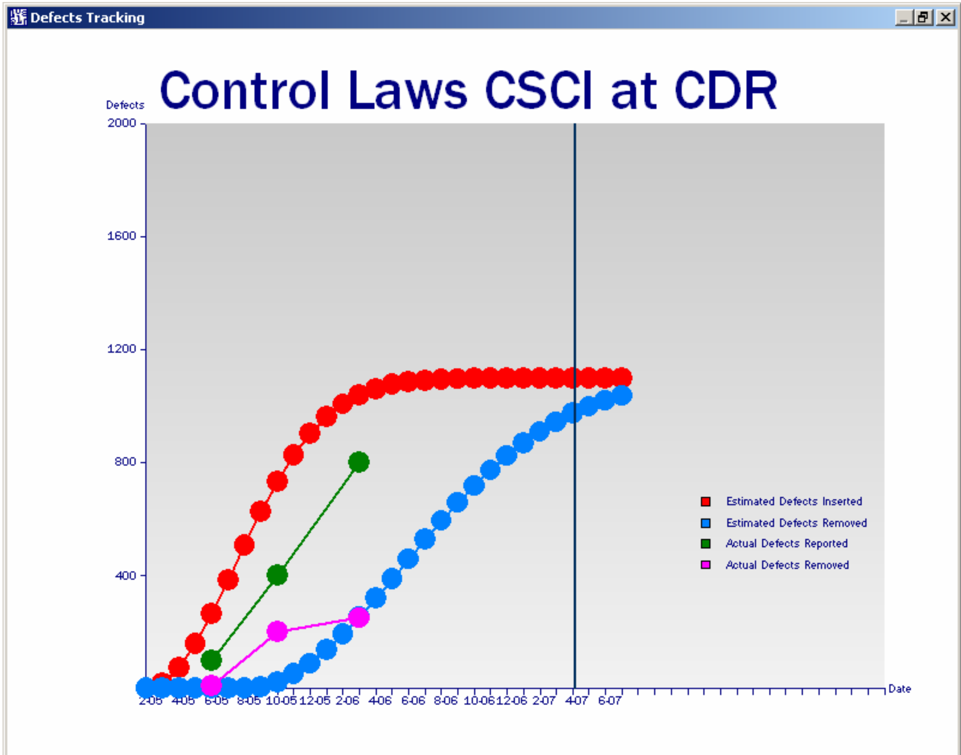

Figure 13: Prototype Defects Tracking Chart

PPMC Report

Data Value	Baseline Estimate	Baseline at Complete		Current Estimate		Estimate at Complete	
Development Schedule Mont...	26.16	27.91	7%	26.16	0%	27.91	7%
Development Effort Months	472.24	661.83	40%	472.24	0%	661.83	40%
Development Effort Hours	71,781	100,598	40%	71,781	0%	100,598	40%
Development Base Year Cost	0	0	0%	0	0%	0	0%
Start Date	2/23/05	2/23/05		2/23/05		2/23/05	
Completion Date	4/27/07	6/19/07		4/27/07		6/19/07	
Effective Lines Only	50,000			50,000	0%		
Effective Functions Only	0			0	0%		
Effective Size	50,000			50,000	0%		
PERFORMANCE INDICES							
CPI	0.71			0.71	0%		
SPI	0.91			0.91	0%		
TCPI	0.65			0.65	0%		
TPI	0.94			0.94	0%		
VARIANCE							
CV	-8,194			-8,194	0%		
SV	-2,121			-2,121	0%		
TV	-0.78			-0.78	0%		
ACCOMPLISHMENTS							
ACWP thru Latest Snapshot	28,604			28,604	0%		
Cost thru Latest Snapshot	0			0	0%		
BCWP thru Latest Snapshot	20,410			20,410	0%		
BCWP % thru Latest Snapshot	28.43%			28.43%	0%		
BCWS thru Latest Snapshot	22,531			22,531	0%		
Productivity Lines/PM	292.27			292.27	0%		
Productivity Functions/PM	0.00			0.00	0%		

Figure 14: Prototype PPMC Report

Summary and Conclusion

Purpose Revisited

This paper has reviewed the fundamentals of software project management and of Performance Measurement (including proposed extensions) and then examined a proposed process called Parametric Project Monitoring and Control (PPMC) whereby accepted algorithms currently used for software cost and schedule estimation during the project planning process are incorporated into the forecasting and re-baselining processes to yield a more-realistic time-range prediction of a project's cost and duration.

Areas of Future Study

The following are suggested opportunities for improving PPMC:

Identify new measures and metrics that can provide better insight into project health and status.

Investigate methods for automating the Performance-Based Forecasting and Re-Baselining Process. Regarding the iterative calibration process, it might be possible to develop a system of equations that combine the fundamental software estimation equations with the equations for calculating Performance Measurement's performance indices such that the calibration coefficients could be resolved directly; i.e., avoiding the iterative guessing process.

Develop new graphic and tabular representations of the measures and metrics data that improve communicating a project's health and status.

Investigate the idea of some sort of project diagnostic expert system that would combine PPMC measures and metrics and provide a list of suggested potential project problems that are indicated by the given values of these measures and metrics.

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[1] CMMI® Product Team, *Capability Maturity Model® Integration (CMMI™), Version 1.1*, Pittsburgh, PA: Software Engineering Institute, Carnegie Mellon University, 2002.

[2] Halliday, D., Resnick, R., *Physics: Parts 1 & 2*, Third Edition, John Wiley & Sons, New York, NY, 1997.

[3] Mish, F. (Editor in Chief), *Merriam-Webster's Collegiate Dictionary*, Tenth Edition, Merriam-Webster, Incorporated, Springfield, MA, 1999.

[4] Ross, M., "Managing Software Size," *Proc. Joint ISPA / SCEA 2003 Conference*, June 2003.

Biography

Michael A. Ross has over 30 years of practical experience in software engineering as a developer, manager, process champion, consultant, instructor, and award-winning international speaker.

Mr. Ross is currently the Chief Engineer of Galorath Incorporated, makers of the SEER suite of estimation tools, where, for the past three years, he has been responsible for the advancement and realization of the technology aspects of Galorath's mission and vision.

Prior to joining Galorath, Mr. Ross was Vice President of Education Services for Quantitative Software Management, Inc. (makers of the SLIM suite of software estimating tools). He was responsible for the development and delivery of all QSM training. During his seven-year tenure with QSM, he served as one of the company's primary consultants and analysts working with Fortune 500 companies and government agencies in the areas of software measurement, sizing, estimating, tracking, forecasting, and benchmarking.

Mr. Ross, during 17 years with Honeywell Air Transport Systems (formerly Sperry Flight Systems) and 2 years with Tracor Aerospace, developed or managed the development of embedded software for avionics systems installed various commercial airplanes including the Boeing 737-500, 757, 767, 777, the Douglas MD-11, the Lockheed L1011-500, the British Aerospace BAe-146, the Airbus A320; and for expendable countermeasures systems installed in various military aircraft and missiles. He also co-founded Honeywell Air Transport Systems' process improvement team (later to become its SEPG), served as its focal for software project management process improvement, and served as a Honeywell corporate SEI CMM assessor.

Mr. Ross did his undergraduate work at the United States Air Force Academy and Arizona State University, receiving a Bachelor of Science in Computer Engineering. He is a member of the Project Management Institute (PMI), the Institute of Electrical and Electronics Engineers (IEEE), the International Function Points Users Group (IFPUG), the International Society of Parametric Analysts (ISPA), the Society of Cost Estimating and Analysis (SCEA), the Arizona Software Association, and the Phoenix area Software Process Improvement Network.

The Road to Process Improvement Successes:

CMMI Level 5/ISO 9001:2000 Business Model

BAE Systems Lines of Business

BAE SYSTEMS

BAE Systems

Electronics & Integrated Solutions

- Platform Solutions
- Sensor Systems
- Advanced Systems & Technology
- Electronic Protection
- Communication, Navigation, Ident. & Reconnaissance
- Information Warfare
- National Security Solutions
- Center for Transformation

Avionics and Controls
Communications
Electronic Warfare
Integrated Systems
Sensors

Customer Solutions

- BAE-IT
- BAE Systems Ship Repair
- Technology Solutions & Services

Information Technology
Sub-systems Integration
Operations & Maintenance
Systems Engineering and Technical Assistance
Logistics Solutions
Ship Repair Services

Land & Armaments

- Armament Systems
- Ground Systems
- Steel Products
- Bofors
- Land Systems
  - Hagglunds
  - Weapons & Vehicles
  - Munitions & Ordnance
  - South Africa (OMC)
- International Division
  - FNSS

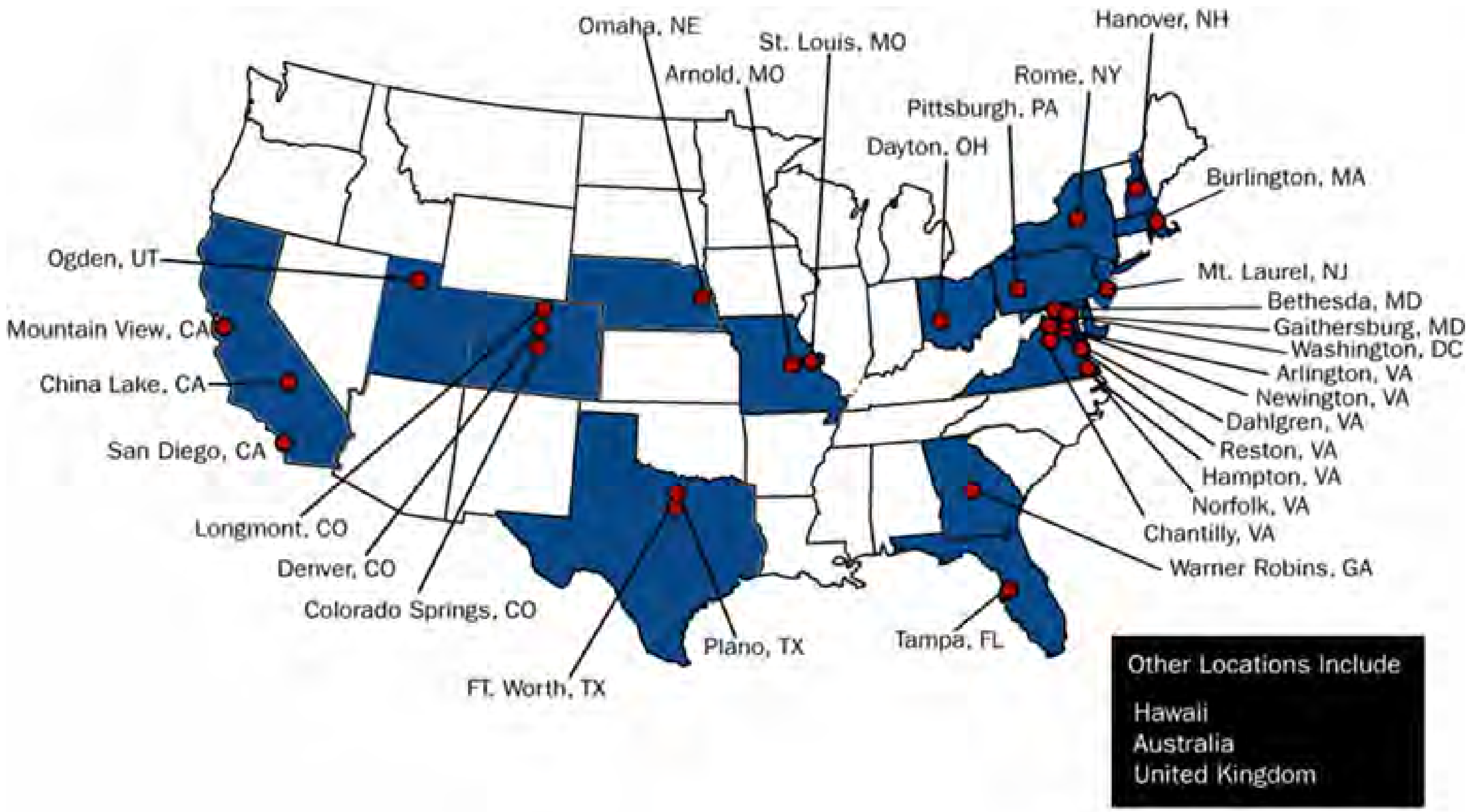
Combat Vehicle Systems
Naval Guns and Launchers
Intelligent Munitions
Rapid Prototyping
Flexible Manufacturing
Life Cycle Support

BAE SYSTEMS


National Security Solutions
Remarkable People
Remarkable Performance
Trusted Partner
BAE SYSTEMS

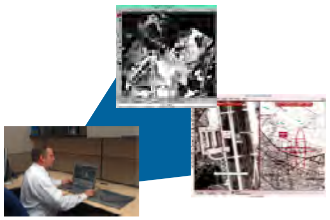
National Security Solutions
Employees and sites

–56 sites across the US
–Nine sites in other countries

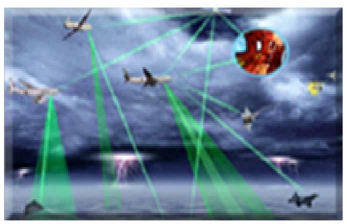


National Security Solutions
Business Areas

BAE SYSTEMS



Systems Integration
Large-scale system-of-systems integration of information systems for the defense and intelligence community



Intelligence Systems
Image management and exploitation systems for mapping, charting, geodesy, and intelligence applications

Defense Systems
Image processing, mission management, and C4ISR technologies for end-to-end mission performance, targeting and test solutions for advanced defense electronic systems

Geospatial Products and Solutions
Commercial Software for Photogrammetry, Mapping & GIS, Imagery Exploitation, C4ISR, Targeting, Visualization & Simulation, Natural Resource Management, and Vertical Obstruction Identification

Advanced Information Technologies
Developing advanced technology solutions that provide integrated, high performance capabilities for the entire information chain.

Road to Process Improvement (PI) Successes

CMMI Level 5 / ISO 9001:2000 Business Model

Topics Covered

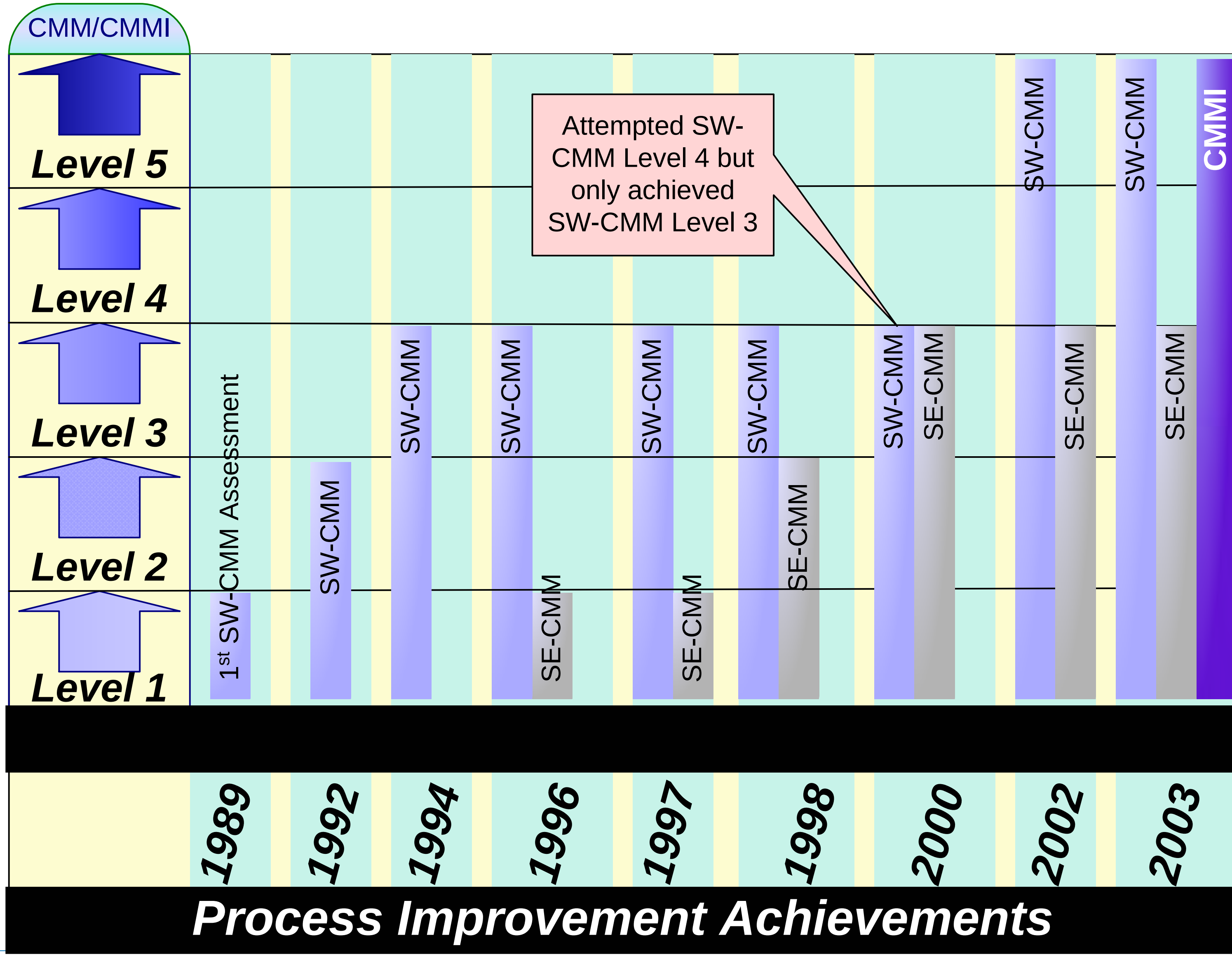
– PI Evolution Roadmap

– PI Expansion

– PI and Business Impacts/Value Realized

PI Evolution Roadmap

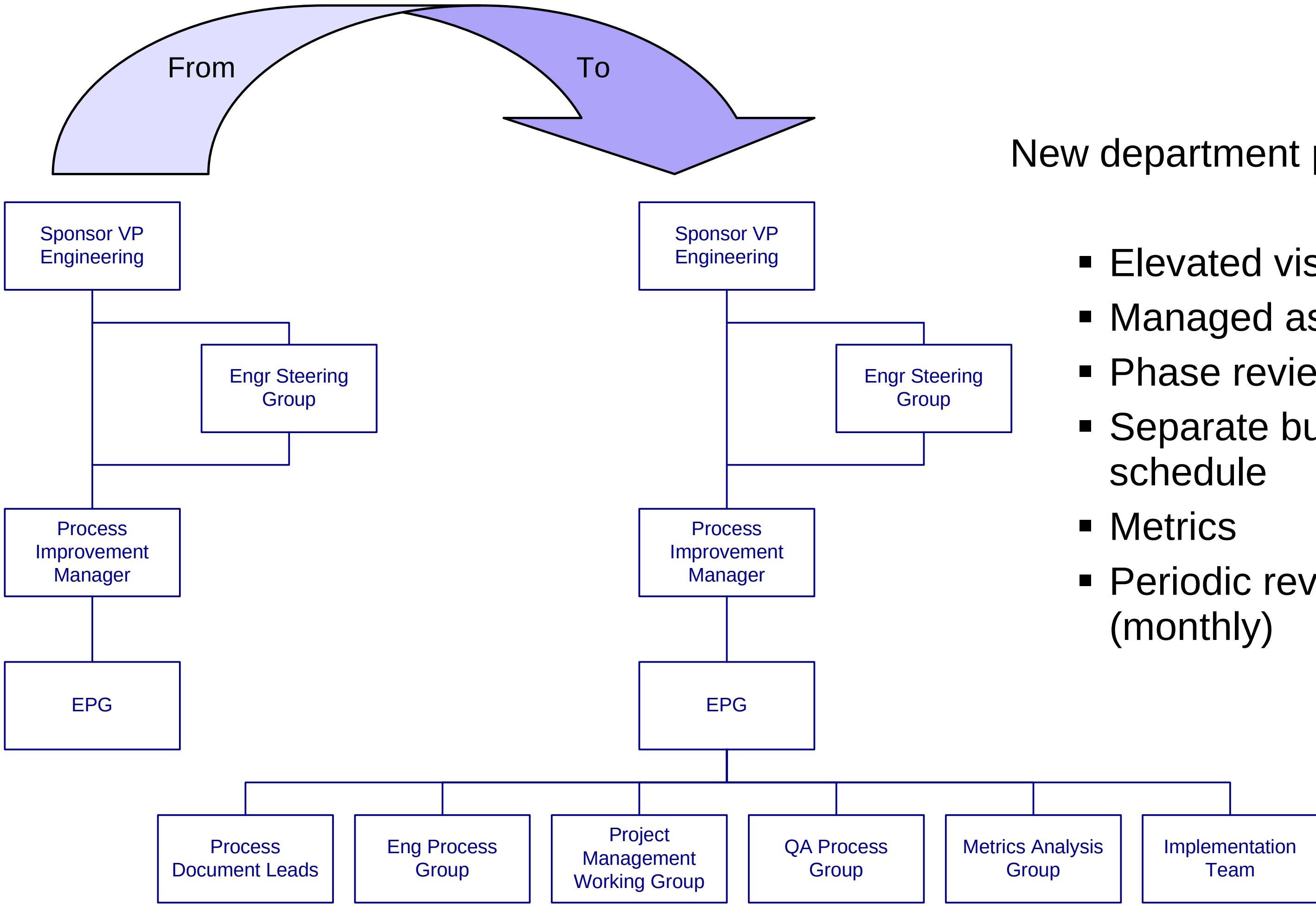
NSS Process Improvement History: CMM/CMMI



PI Evolution Roadmap

Process Improvement Organization Elevated and Broadened

BAE SYSTEMS



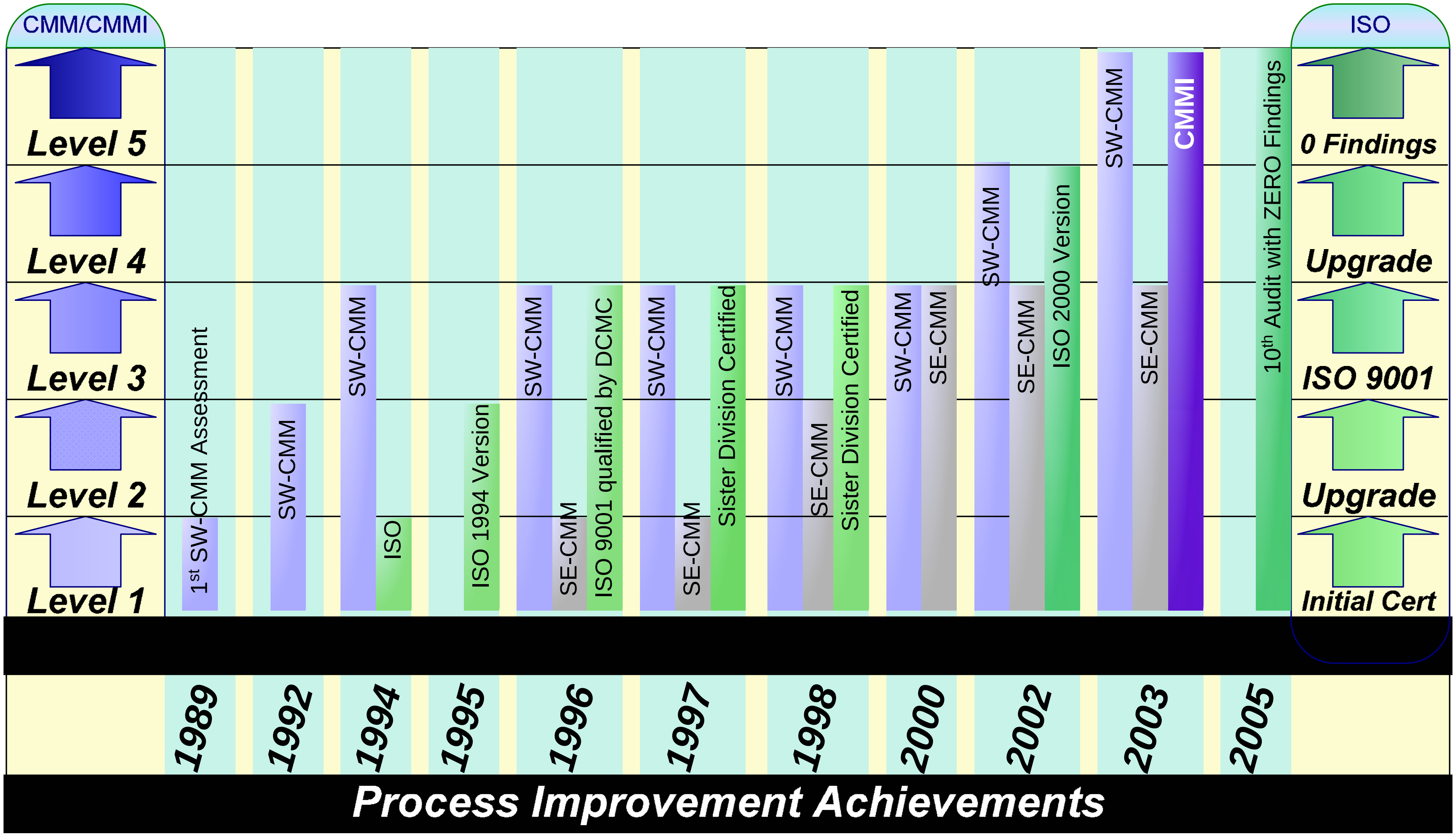
New department provides focus

- Elevated visibility
- Managed as a project
- Phase reviews
- Separate budget, resources, schedule
- Metrics
- Periodic reviews with Exec Mgt (monthly)

PI Evolution Roadmap

NSS Process Improvement History: CMM/CMMI and ISO

BAE SYSTEMS



PI Evolution Roadmap

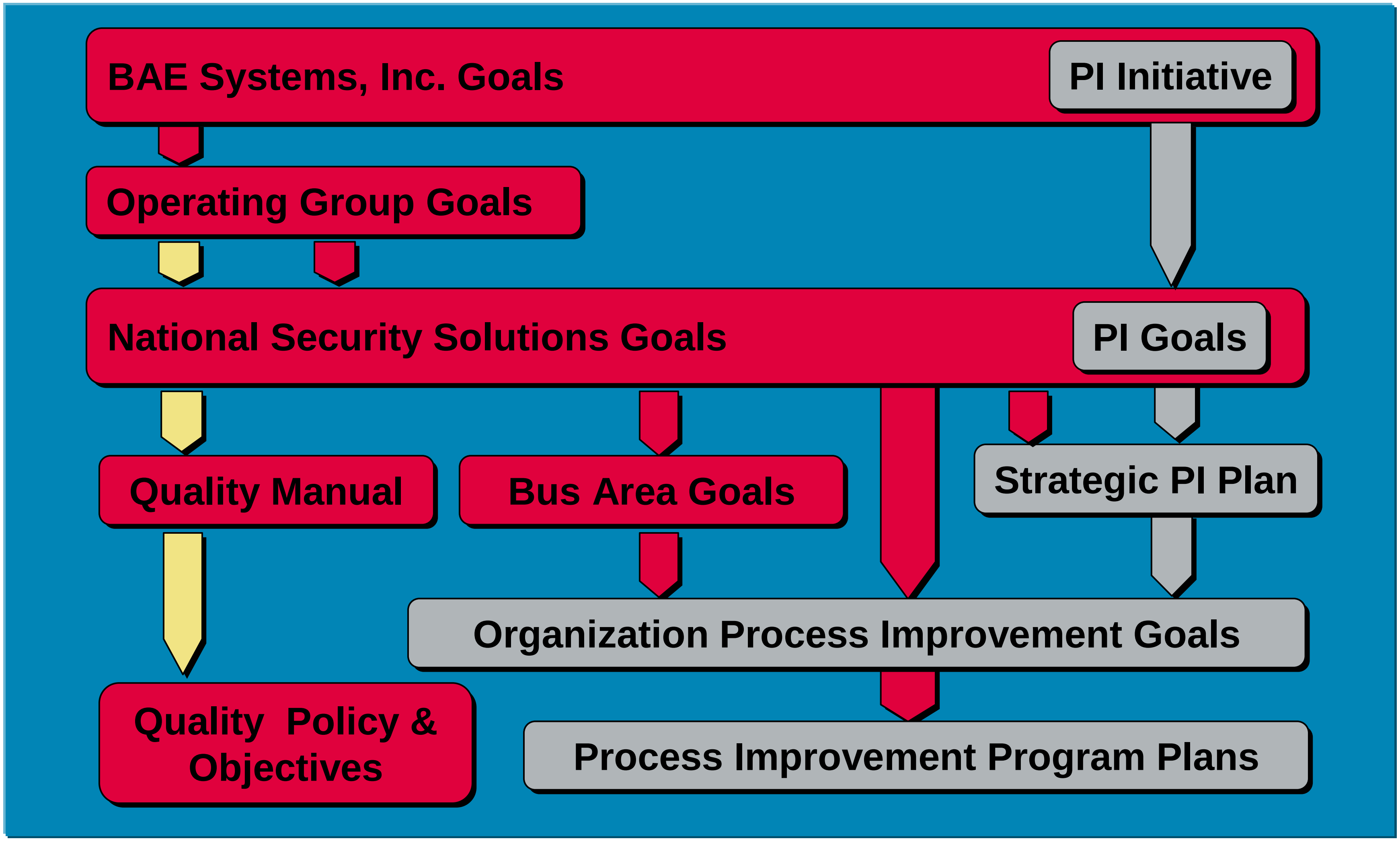
ISO 9001 – Quality Management System Evolution

- Prior to September 1994
  - Approved to Military Standards
  - Changing DoD initiatives for procurement reform

- Issues
  - Given 12 months to achieve initial ISO 9001 certification (typically took 18 months, and 70% failed assessment the first time)
  - Documentation overkill and no time to re-architect
  - Lack of engineering-specific process documentation
  - Poor control and management of records and training needs

- Improvements
  - Selected personnel to receive formal ISO Implementation and Auditor Training
  - Established multi-disciplined ISO Steering Committee
  - Conducted company-wide ISO Awareness Training
  - Generated requirements-to-document trace mechanism
  - Developed and implemented required process documentation with increased focus on engineering practices
  - Strengthened the commitment to training
  - Implemented company-wide mechanism for control of records
  - Achieved ISO Certification in 8 months and passed the first time

PI Expansion
Flow Down of Goals

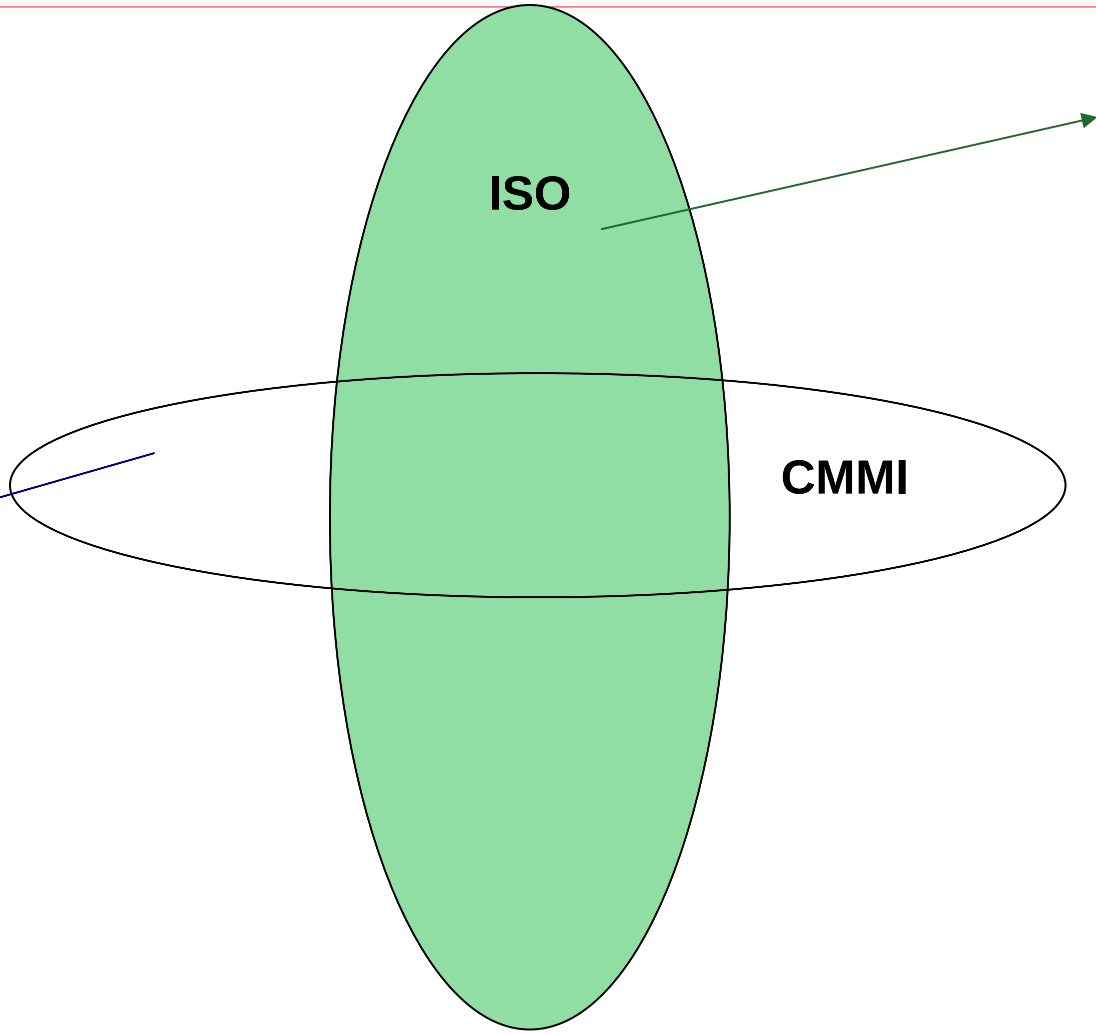


PI Expansion

Entire Management System

BAE SYSTEMS

Management Steering Group (MSG) provides overall direction and guidance for process development, improvement, and implementation and deployment activities across the National Security Solutions LOB. (CMMI driven)



Executive Quality Review (EQR) provides periodic opportunities for executive management to review key indicators that reflect the suitability, adequacy, effectiveness and improvement of the Quality Management System at National Security Solutions. (ISO driven)

PI Expansion
Membership

BAE SYSTEMS

Organization/Function	EQR	MSG
President (EQR Sponsor/MSG Co-Sponsor)	✓	✓
Organizational Group VP Performance Excellence (MSG Co-Sponsor)	✓	✓
VP & Deputy GM	✓	✓
Chief of Staff	✓	
Director Performance Excellence (EQR/MSG Chair)	✓	✓
VP Systems Integration	✓	✓
VP Intelligence Systems	✓	✓
VP Defense Systems	✓	✓
VP Geospatial Products & Solutions	✓	✓
VP & GM Advanced Information Technologies	✓	✓
VP Engineering	✓	✓
VP Operations	✓	✓
VP Business Development	✓	✓
VP AIT Strategic Growth	✓	
Director Integration	✓	
VP Legal	✓	
VP Contracts	✓	
VP Finance	✓	
Director Human Resources	✓	✓
Director Communications	✓	
Director Security	✓	
Director Information Technology	✓	✓
Organizational Process Group Chair		✓
Organizational Process Group Expansion Chair		✓

PI Expansion

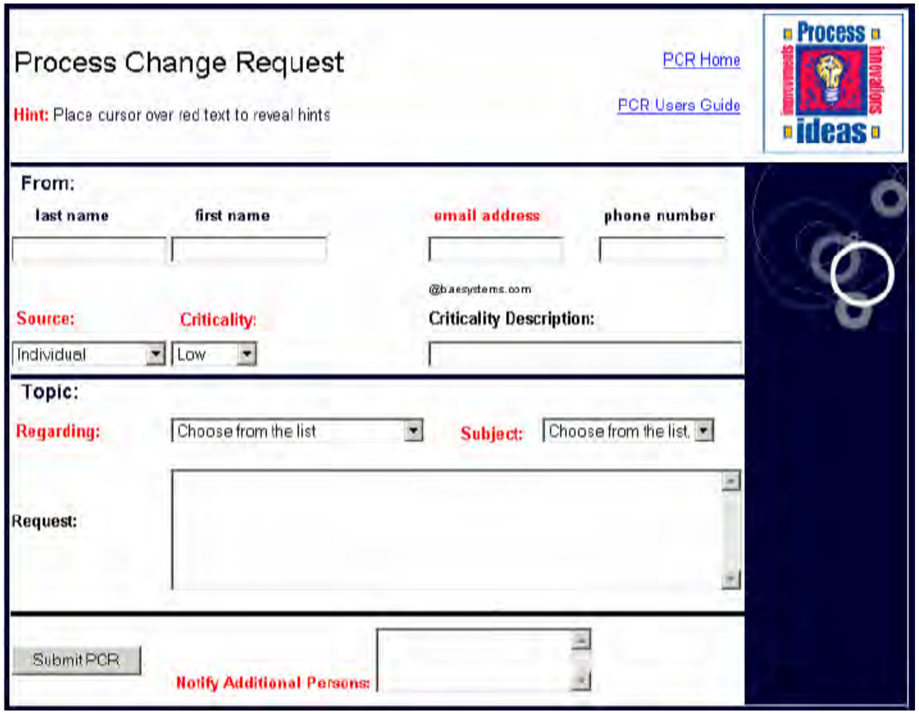
Entire Management System – Shared Tools/Mechanisms/Enablers

- Process Change Request (PCR)
- Document Restructure Team (DRT)
- Sector-Wide Integration of Requirement Mapping (SWIRM)
- Corrective/Preventive Action
- Quality Audit System (QAS) and Process Health
- Customer Satisfaction

PI Expansion
Process Change Request (PCR)

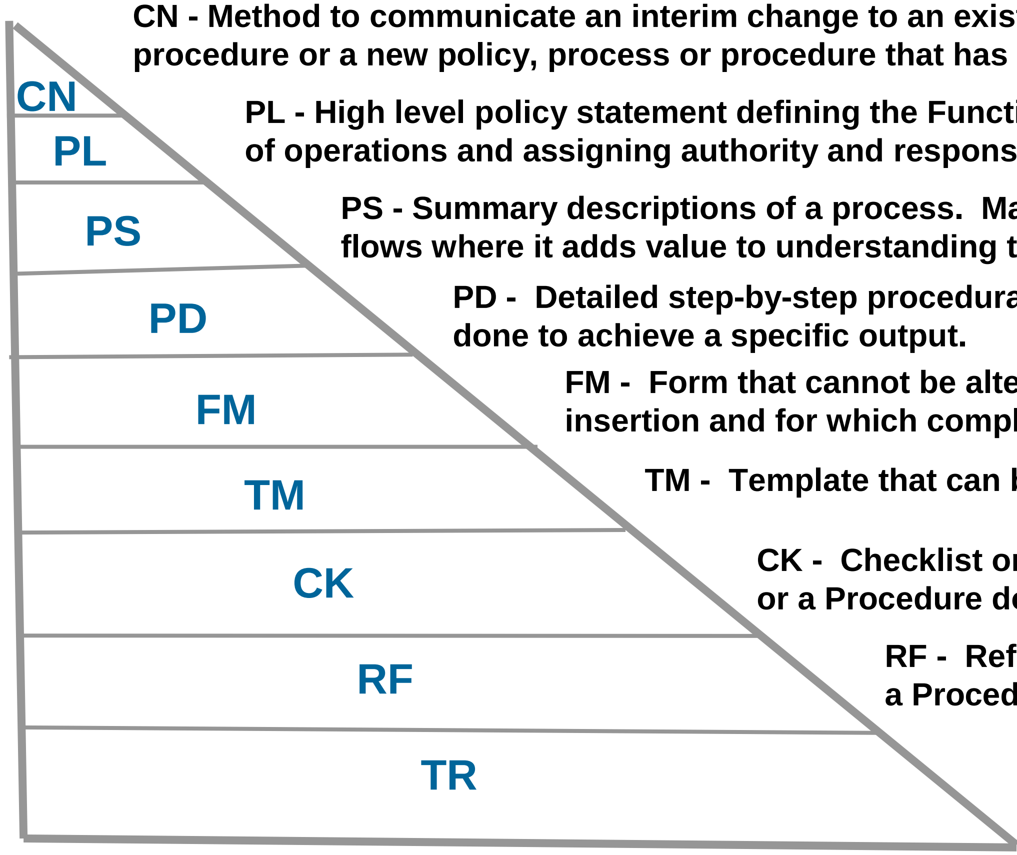
BAE SYSTEMS

- Employees provide feedback (changes and additions) on processes, tools, and training material
  - Web based PCR form implemented
  - Easy use resulted in increased visibility and involvement
- Document PCRB decisions
- PCRs assigned to process owners for evaluation and implementation



PI Expansion

Process Document Structure



CN - Method to communicate an interim change to an existing policy, process or procedure or a new policy, process or procedure that has not been released to DOLLS.

PL - High level policy statement defining the Functional and/or Organizational conduct of operations and assigning authority and responsibility for implementation.

PS - Summary descriptions of a process. May include diagrams of process flows where it adds value to understanding the process.

PD - Detailed step-by-step procedural instructions of what precisely has to be done to achieve a specific output.

FM - Form that cannot be altered that identifies specific information for insertion and for which completion results require retention.

TM - Template that can be used by a project as a starting point.

CK - Checklist or other Aide to complement a Process or a Procedure document.

RF - Reference Doc to complement a Process or a Procedure document.

TR - Types of training material to include: Formal course material developed by the company, job aides, conference / brown bag presentations, etc.

PI Expansion

Sample Branch of the Integrated Engineering Process Document Tree

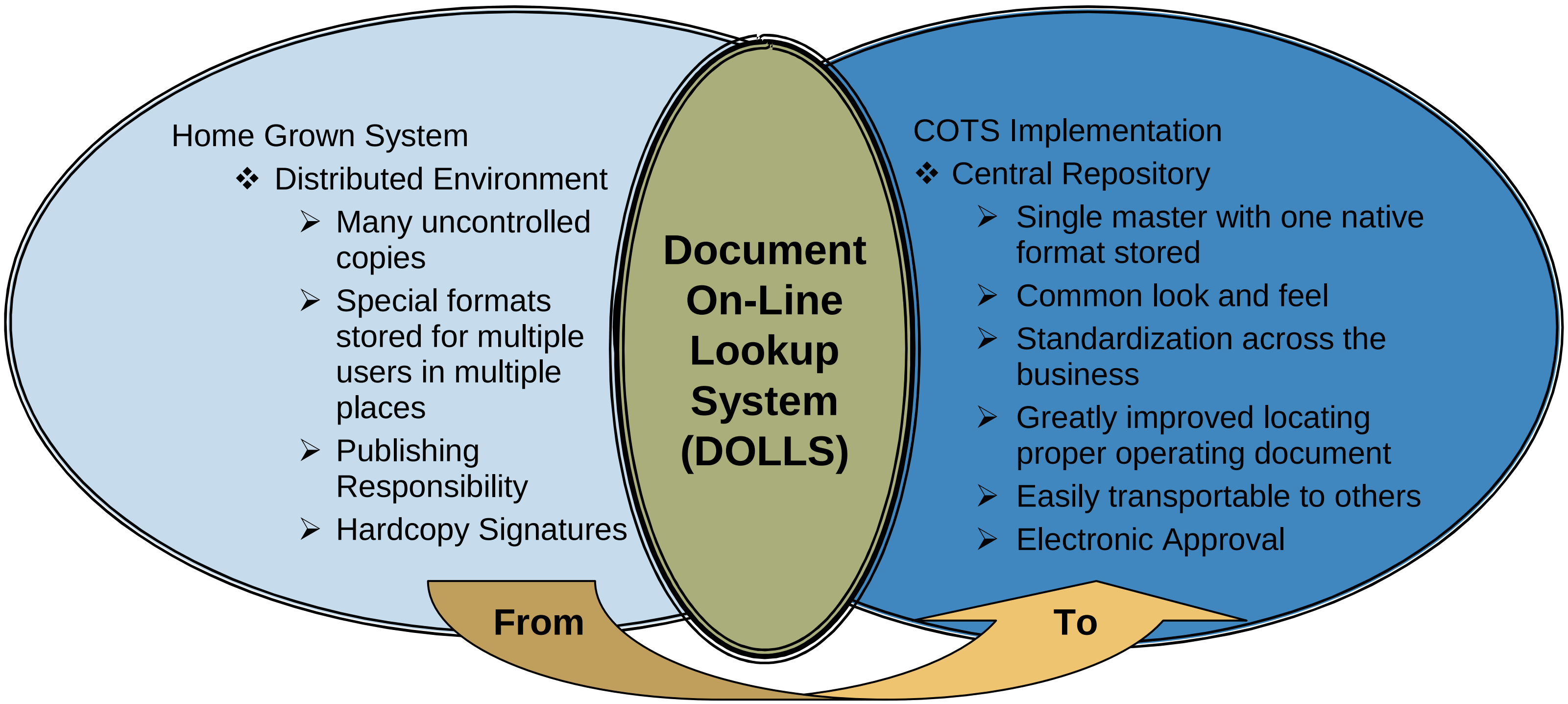
- **Engineering Development Policy (PL)**
  - **Perform System Acceptance Test Process (PS)**
    - Perform System Acceptance Test – Test Design Procedure (PD)
      - Test Design Template FM
      - Test Plan Template FM
      - Test Description Example RF
      - GFE/GFI Template RF
      - Component-Based Testing White Paper RF
      - Component Test Plan Template RF

FM = Form

RF = Reference

Company-wide Directives Restructure

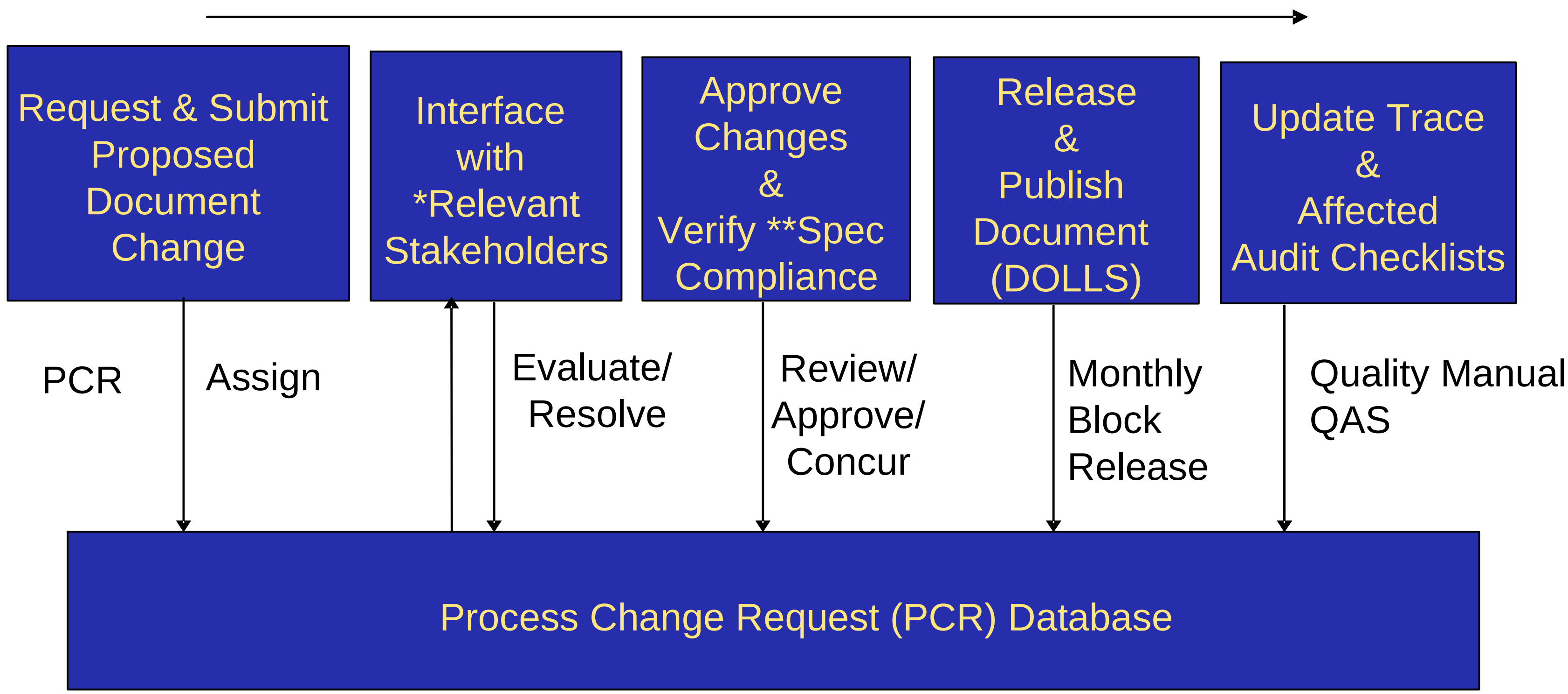
Established a Document System that Fosters and Promotes Continuous Improvement



PI Expansion

Sector-Wide Integration of Requirements Mapping (SWIRM)

Maintain Document Compliance and Trace



* Relevant Stakeholders:
- Process/Document Owners
- Compliance Authority/Coordinators

** Specification (Spec) Requirements:
- CMMI
- ISO 9001
- Corporate/Management Directives
- Contractual/Regulatory Requirements

PI Expansion

Quality Audit System (QAS) and Process Health

Goal: Exceed 90% health.

Goal Status: All Process Areas exceeded 90%.

PROCESS HEALTH
PROGRAM LEVEL AUDITS -- BY PROCESS AREA

PROCESS AREA	12 MONTH PROCESS HEALTH '01-JUN-04 thru '31-MAY-05							3 MONTH PROCESS HEALTH '01-MAR-05 thru '31-MAY-05						
	OBSERVATIONS			DISCREPANCIES				OBSERVATIONS			DISCREPANCIES			
	High	Med	Low	High	Med	Low	Health	High	Med	Low	High	Med	Low	Health
KEY PRACTICE - QUICK CHECK	22	629	0	2	22	0	**96.1%**	12	314	0	2	16	0	**94.1%**
PROJECT PLANNING	59	83	46	1	0	0	**99.1%**	13	24	14	0	0	0	**100.0%**
PROJECT MONITORING AND CONTROL	61	199	25	2	0	4	**98.4%**	0	0	0	0	0	0	n/a
SUPPLIER AGREEMENT MANAGEMENT	21	25	9	0	0	0	**100.0%**	9	15	7	0	0	0	**100.0%**
INTEGRATED PROJECT MANAGEMENT	52	147	66	0	0	2	**99.8%**	0	0	0	0	0	0	n/a
RISK MANAGEMENT	68	99	0	0	1	0	**99.6%**	13	26	0	0	0	0	**100.0%**
QUANTITATIVE PROJECT MANAGEMENT	19	87	67	0	4	0	**97.3%**	5	21	14	0	0	0	**100.0%**
REQUIREMENTS MANAGEMENT	93	45	13	0	0	2	**99.7%**	24	10	2	0	0	0	**100.0%**
REQUIREMENTS DEVELOPMENT	91	105	51	0	0	0	**100.0%**	0	8	0	0	0	0	**100.0%**
TECHNICAL SOLUTION	138	213	54	0	3	1	**99.3%**	16	12	0	0	0	0	**100.0%**
PRODUCT INTEGRATION	143	140	185	0	1	8	**99.2%**	26	32	27	0	0	0	**100.0%**
VERIFICATION	230	180	179	1	0	0	**99.7%**	50	33	39	0	0	0	**100.0%**
VALIDATION	95	14	110	1	0	2	**98.9%**	11	0	12	0	0	0	**100.0%**
CONFIGURATION MANAGEMENT	40	54	23	1	1	0	**97.9%**	18	17	11	1	0	0	**96.5%**
PROCESS AND PRODUCT QUALITY ASSURANC	182	126	40	7	3	2	**96.5%**	0	0	0	0	0	0	n/a
MEASUREMENT AND ANALYSIS	84	110	34	2	0	0	**98.6%**	11	12	5	1	0	0	**94.4%**
DECISION ANALYSIS AND RESOLUTION	34	22	29	0	0	0	**100.0%**	0	0	0	0	0	0	n/a
CAUSAL ANALYSIS AND RESOLUTION	18	14	18	0	0	0	**100.0%**	3	10	15	0	0	0	**100.0%**
GENERIC PRACTICES	12	31	39	0	0	0	**100.0%**	0	0	0	0	0	0	n/a
TOTAL	1462	2323	988	17	35	21	**98.6%**	211	534	146	4	16	0	**97.6%**

QAS Query Date '01-JUN-05

Data Source: Quality Audit System. Includes completed audits performed during time period indicated only. A completed audit is one with all audit questions completed and the date the last question was audited occured during the indicated time period.

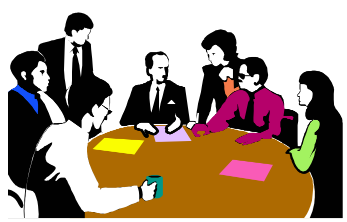
PI Expansion

Corrective Action (C/A) and Preventative Action (P/A)

Corrections

Rework
Fix
Scrap

Trend Analysis



C/A

Root Cause
Action to Prevent Recurrence
(Prevent Recurrence)

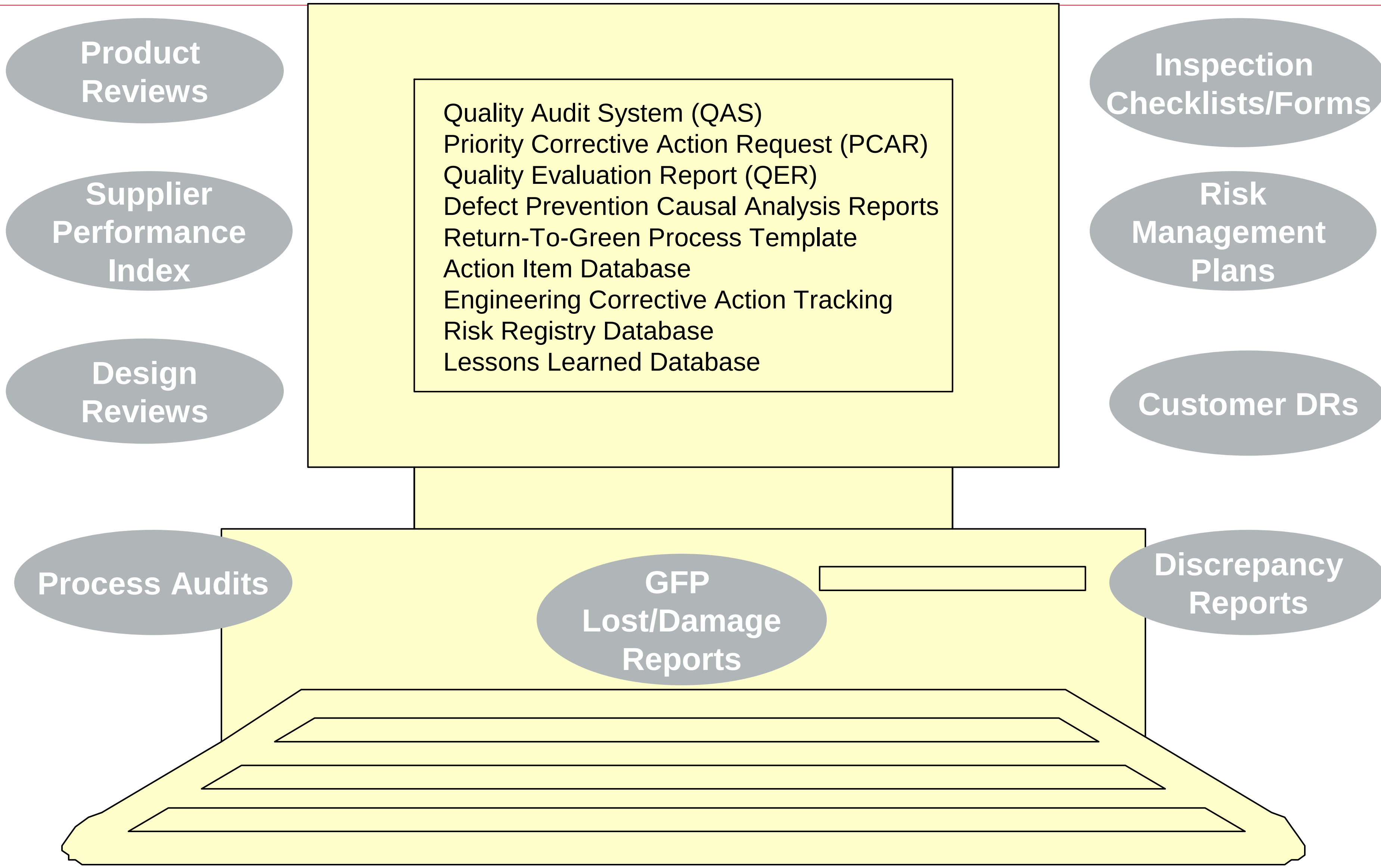
P/A

Determine cause and take actions to mitigate/eliminate potential discrepancies.
(Prevent Occurrence)

PI Expansion

Corrective/Preventive Action Reporting/Tracking Systems

BAE SYSTEMS

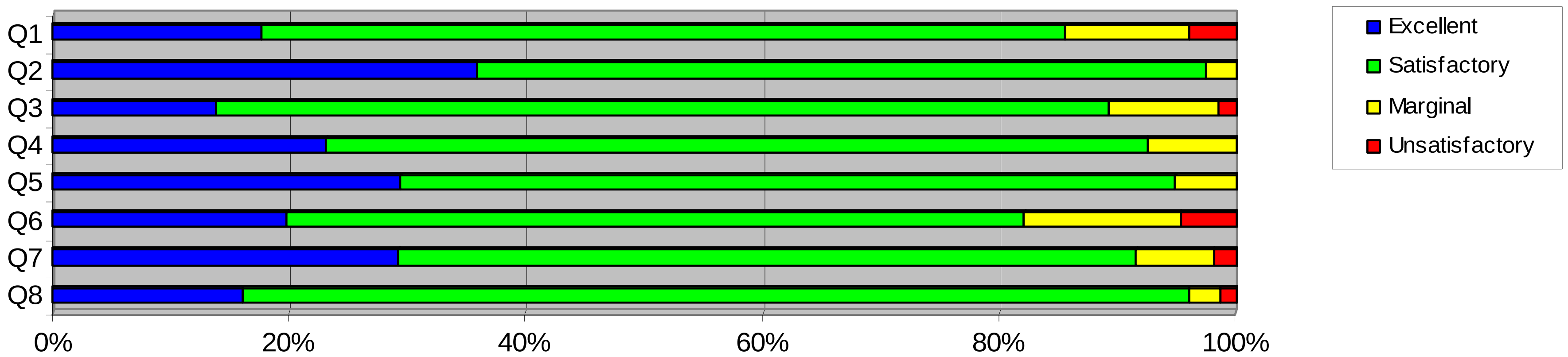


PI Expansion

Internal Customer Satisfaction

BAE SYSTEMS

Information Technology Customer Satisfaction Survey: Common Company Services



<u>Overall Survey Stats</u>
1473 survey requests
320 respondents
(Return Rate: 22%)

Q1 Centralized reprographics services.
Q2 Phone services (telephone, voicemail, teleconferencing, pagers).
Q3 Electronic presentation room (EPR) and video teleconference (VTC) services.
Q4 On-site desktop computer support (installs, moves, adds, changes).
Q5 Corporate application services (Time Reporting, Employee Self Service, Travel)
Q6 How well the IT investments supported the business goals you defined this year.
Q7 IT extended services (computer sales/purchase/reimbursement program).
Q8 Access to Internet and company facilities.

PI Expansion

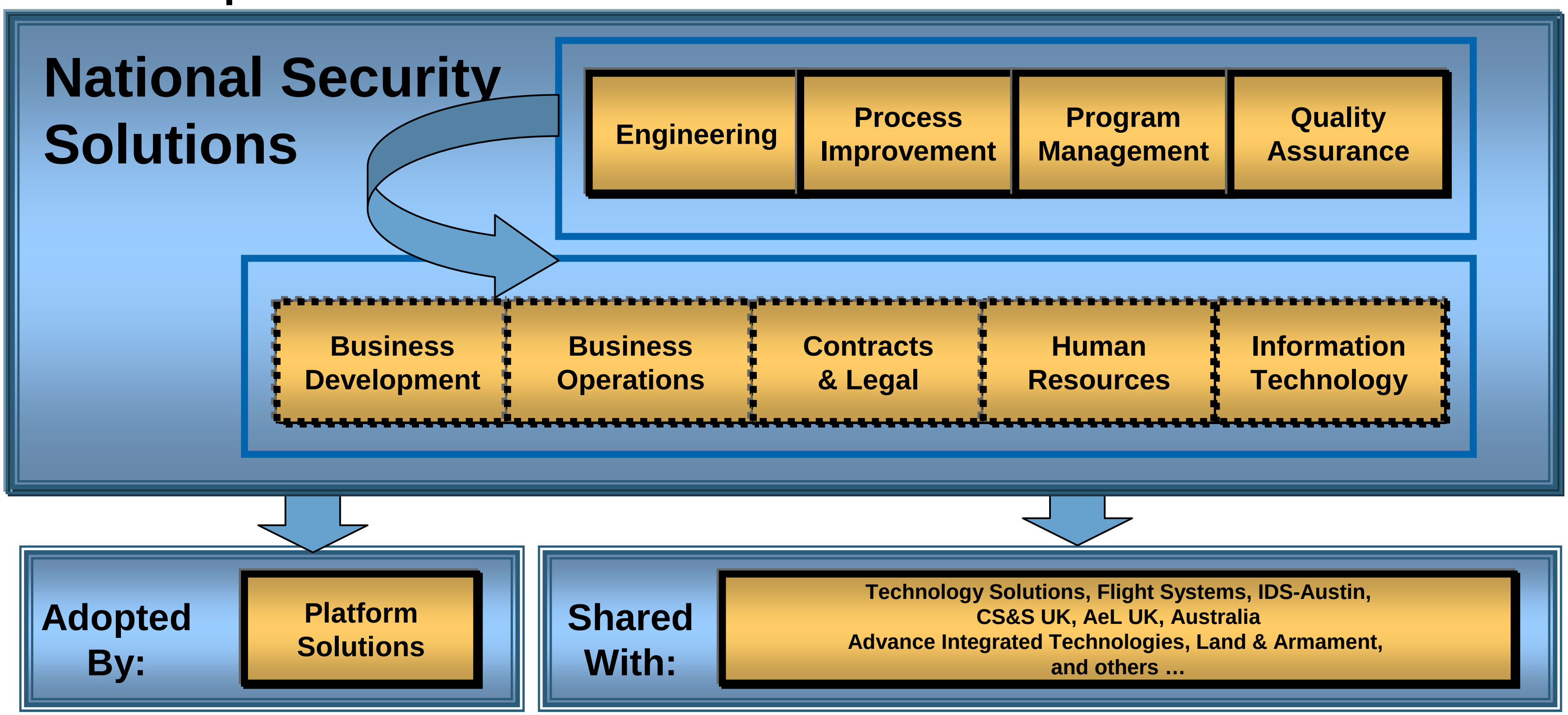
External Customer Satisfaction

	CUSTOMER/ PROGRAM	RATING BY CATEGORY											PROG
		PROD PERF	SYS ENG	SOFT ENG	LOGIST SUPPRT	PROD ASSUR	SCH	COST CONTRL	MGMT RESP	SUBCN MGMT	PROG MGMT	COMM	12 mo run avg
DEFENSE SYSTEMS													
S	XXX	G	G	P	B	G	P	G	P	G	P	B	3.8
S	XXXXXXXX	B	B	N/A	N/A	N/A	B	B	B	N/A	B	G	4.7
S	XXXXXX	B	N/A	N/A	B	B	B	P	B	B	B	P	4.4
S	XXXXXXXXXXX	B	B	B	B	B	B	N/A	B	N/A	B	B	4.9
S	XXXXXXXXXXXXXX	B	B	B	P	B	B	B	B	N/A	B	B	4.8
S+	XXXXXXXXXX	G	P	P	P	G	P	B	P	G	P	P	3.8
S+	XXXXXXXXXXXX	P	P	P	G	P	B	P	B	G	B	P	4.2
S	XXXXXXXXXXXXXXXX	B	P	B	B	B	B	P	B	N/A	B	B	4.6
S	XXXXX	P	N/A	N/A	N/A	G	G	P	B	B	P	P	4.0
C	XXXXXX	B	B	B	P	B	B	B	B	N/A	B	B	5.0
S	XXXXXX	B	B	B	B	B	B	B	B	N/A	B	B	5.0
C	XXXXX	B	B	P	N/A	B	B	B	B	N/A	B	B	4.6
S	XXXXXXXX	B	B	B	B	B	B	B	B	N/A	B	B	4.9
C	XXXXXXXXXXXXXXX	B	P	P	P	G	P	P	B	N/A	B	B	4.3
C	XXXXX	B	G	G	G	G	G	B	G	N/A	B	G	3.6
S	XXX	N/A	B	B	N/A	P	P	P	P	N/A	P	P	4.2
S	XXXX	G	P	N/A	N/A	G	G	N/A	G	N/A	G	G	3.0
S	XXXX	P	P	P	B	P	P	G	P	P	P	P	4.2
C	XXX	G	P	P	P	G	B	P	B	N/A	B	B	4.1
C	XXX	P	P	P	N/A	N/A	P	N/A	B	N/A	B	P	4.0
C	XXX	P	B	B	N/A	B	B	P	B	N/A	B	B	4.1
C	XXXXXXXXXXXXXX	P	P	P	P	G	B	P	B	N/A	B	B	4.2
C	XXXXX	G	P	G	N/A	G	N/A	P	B	N/A	B	B	4.0
INTELLIGENCE SYSTEMS													
C	XXXXXX	N/A	P	B	N/A	P	B	P	P	N/A	P	P	4.3
S	XXXXXXX	G	P	B	G	G	B	P	P	N/A	P	G	3.8
C	XXX	P	P	P	P	P	P	P	P	N/A	P	P	4.1
C	XXXX	P	P	B	N/A	N/A	P	B	B	N/A	P	P	4.3
C	XXXX	N/A	G	G	N/A	G	P	G	G	N/A	G	G	3.1
C	XXXX	P	B	P	B	P	P	P	B	B	B	B	4.5
C	XXXXX	G	P	P	G	N/A	G	G	P	N/A	P	P	3.7
Process Summary - Customer Rating													
B	Percentage 12 Month Running Average	33.3%	35.3%	31.0%	36.7%	28.5%	46.1%	37.8%	68.0%	41.6%	55.5%	57.5%	
P		40.7%	50.8%	57.1%	48.6%	36.8%	35.8%	49.7%	24.6%	10.1%	40.3%	31.8%	
G		25.9%	13.9%	11.9%	14.7%	34.7%	18.1%	12.5%	7.5%	48.3%	4.1%	10.5%	
Y												0.3%	
R													
	Overall Average	4.1	4.2	4.2	4.2	3.9	4.3	4.3	4.6	3.9	4.5	4.5	

PI Expansion

Transferring Best Practices

- Collaborated Architecture within the Organization
- Shared proven Organizational Standard Set of Processes Across Enterprise

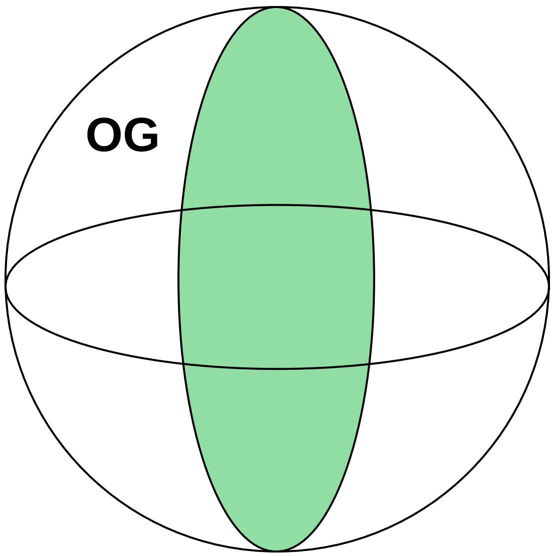


PI Expansion
Operating Group (OG) Regulatory Panels

- Regulatory Panels
  - ISO 9001 and AS 9100
  - ISO 14001 Environmental
  - CMMI

- Representative from each Line of Business

- Purpose:
  - Remove walls that may have existed between sites
  - Benchmark and share best practices within each site and leverage on them
  - Harmonize and integrate regulatory requirements
  - Establish and implement OG level policies to operate as a borderless enterprise



PI and Business Impacts/Value Realized

Improvements Over Past 10 Years

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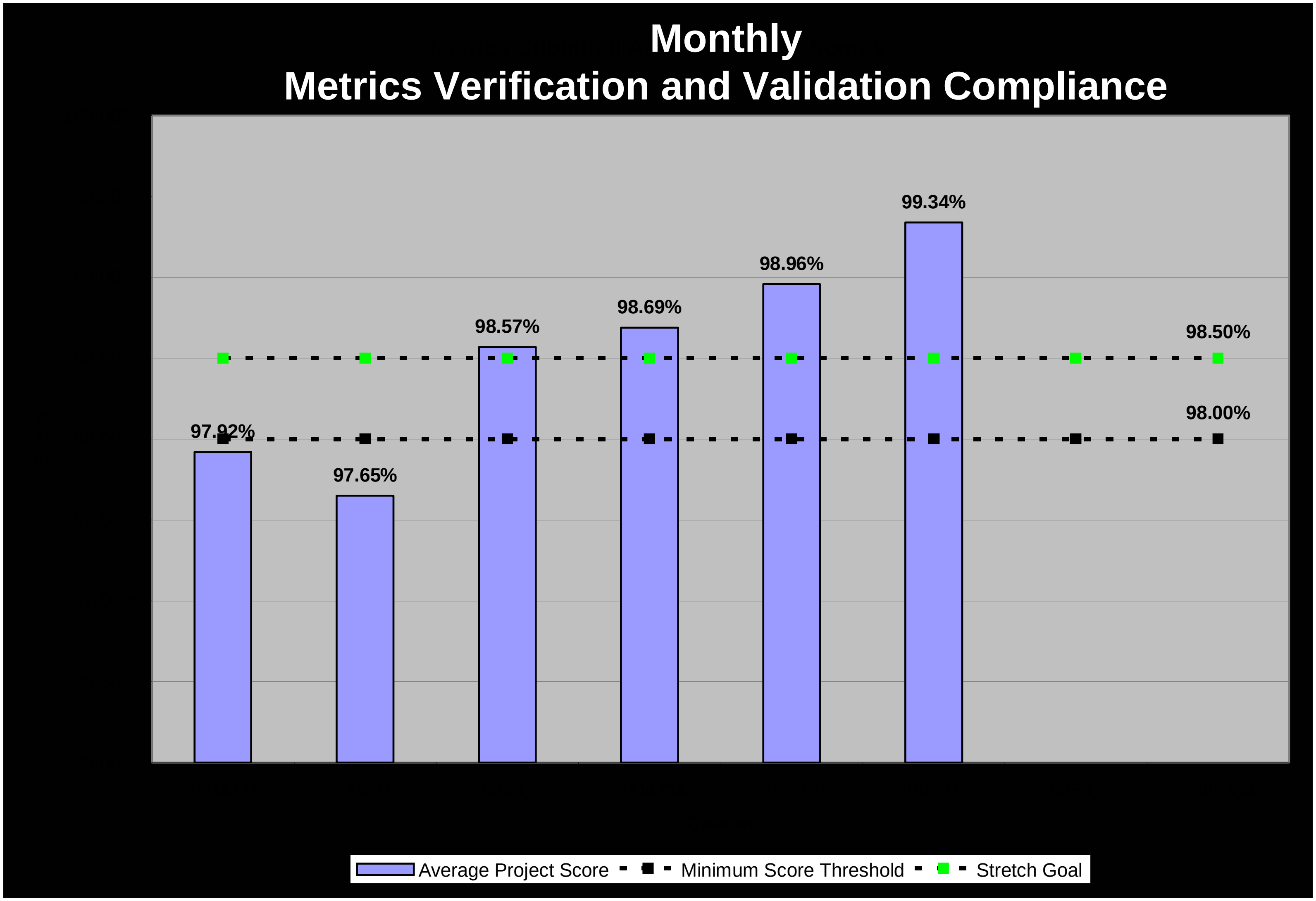
Project Measure	Then	Now
Actual vs. Negotiated cost	+/- 40%	+/- 7%
Cost Performance Index	unknown	1.03
Schedule Performance Index	unknown	0.99
Average Award Fee	90%	98.10%
Greens on Customer Sat. Survey	90%	100%

Process Measure

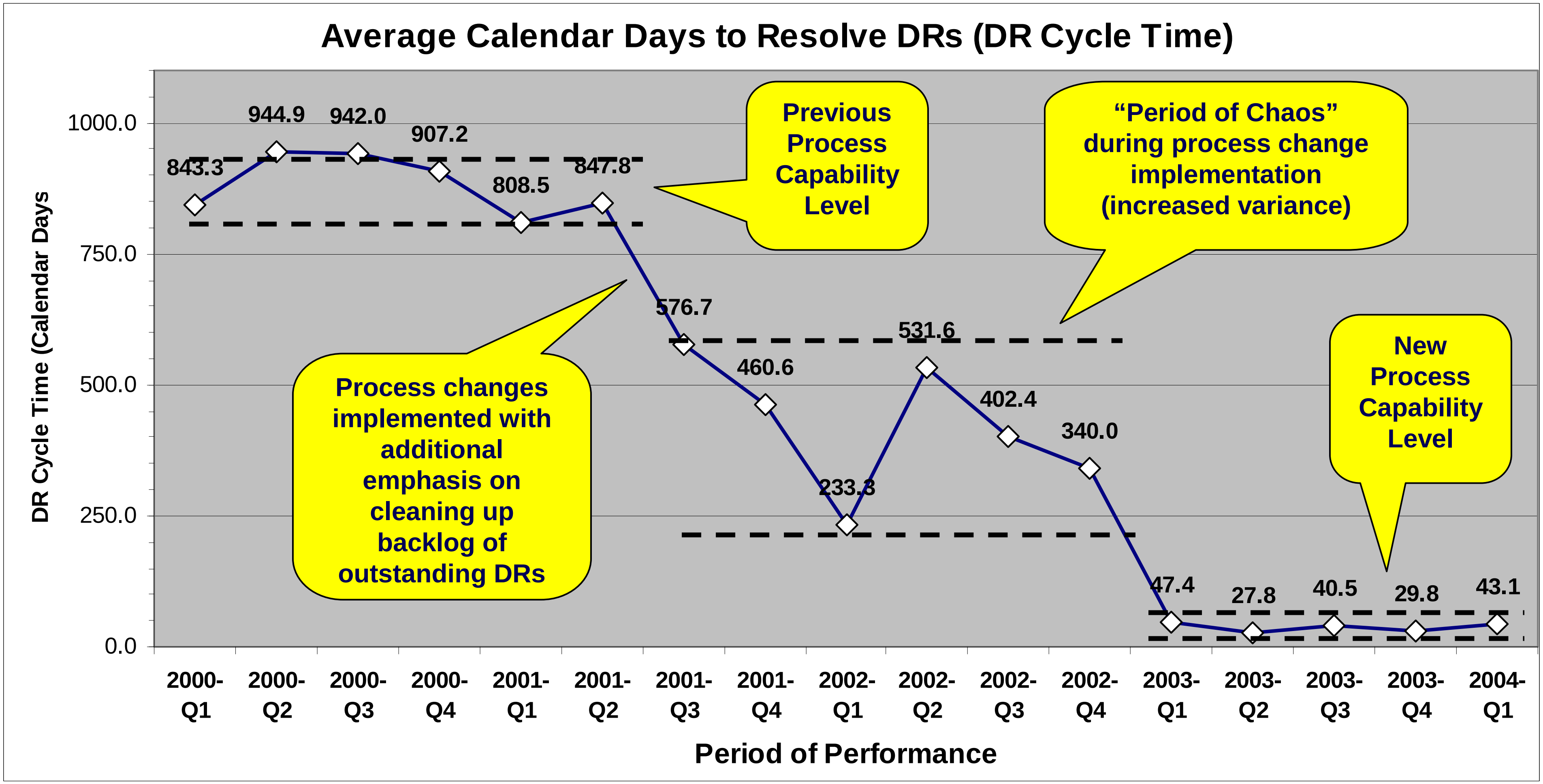
Capability Maturity Model Int. (CMMI)	1	5

PI and Business Impacts/Value Realized
Improved Measurement Reliability



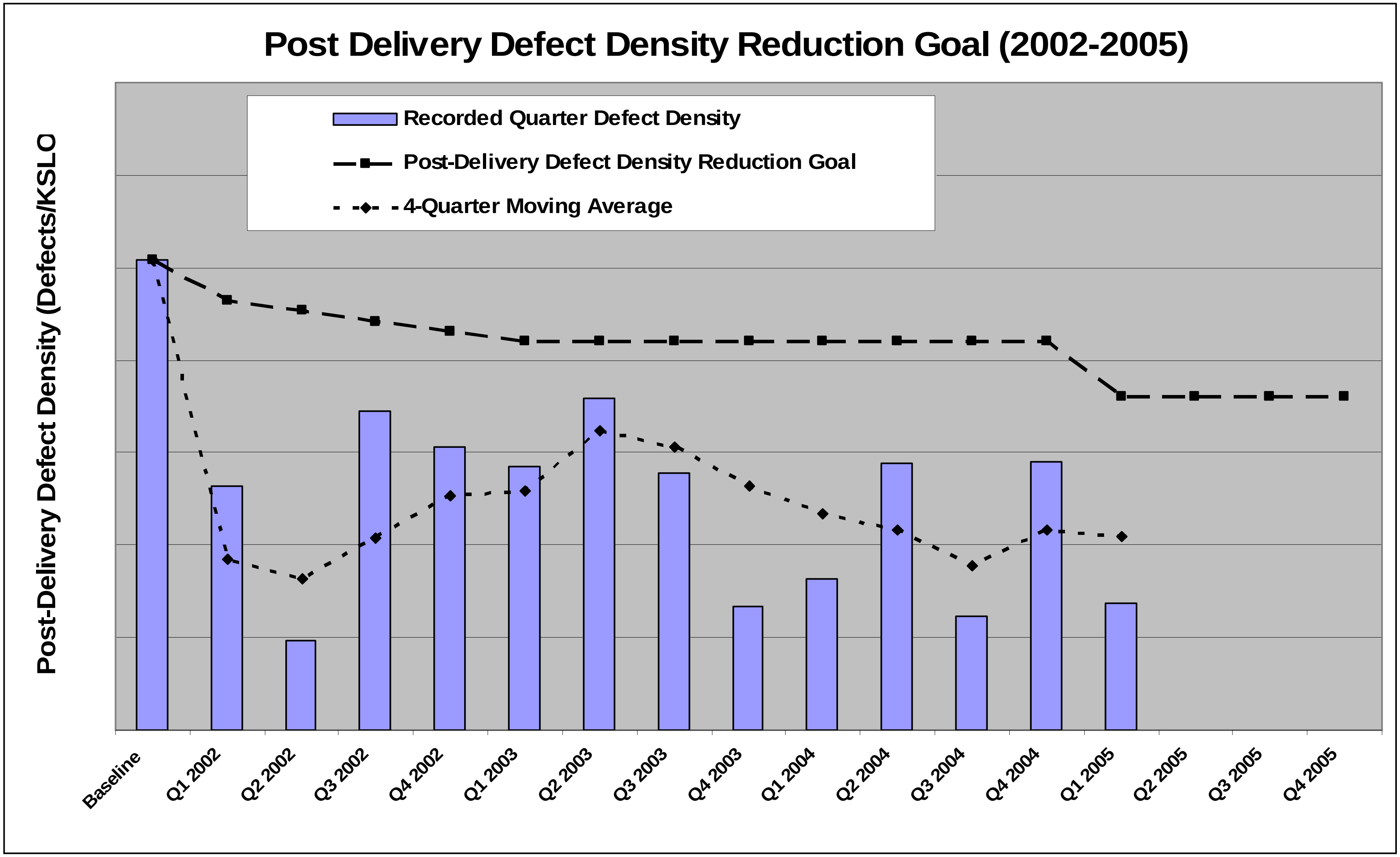
PI and Business Impacts/Value Realized

Less Variability & Increased Predictability



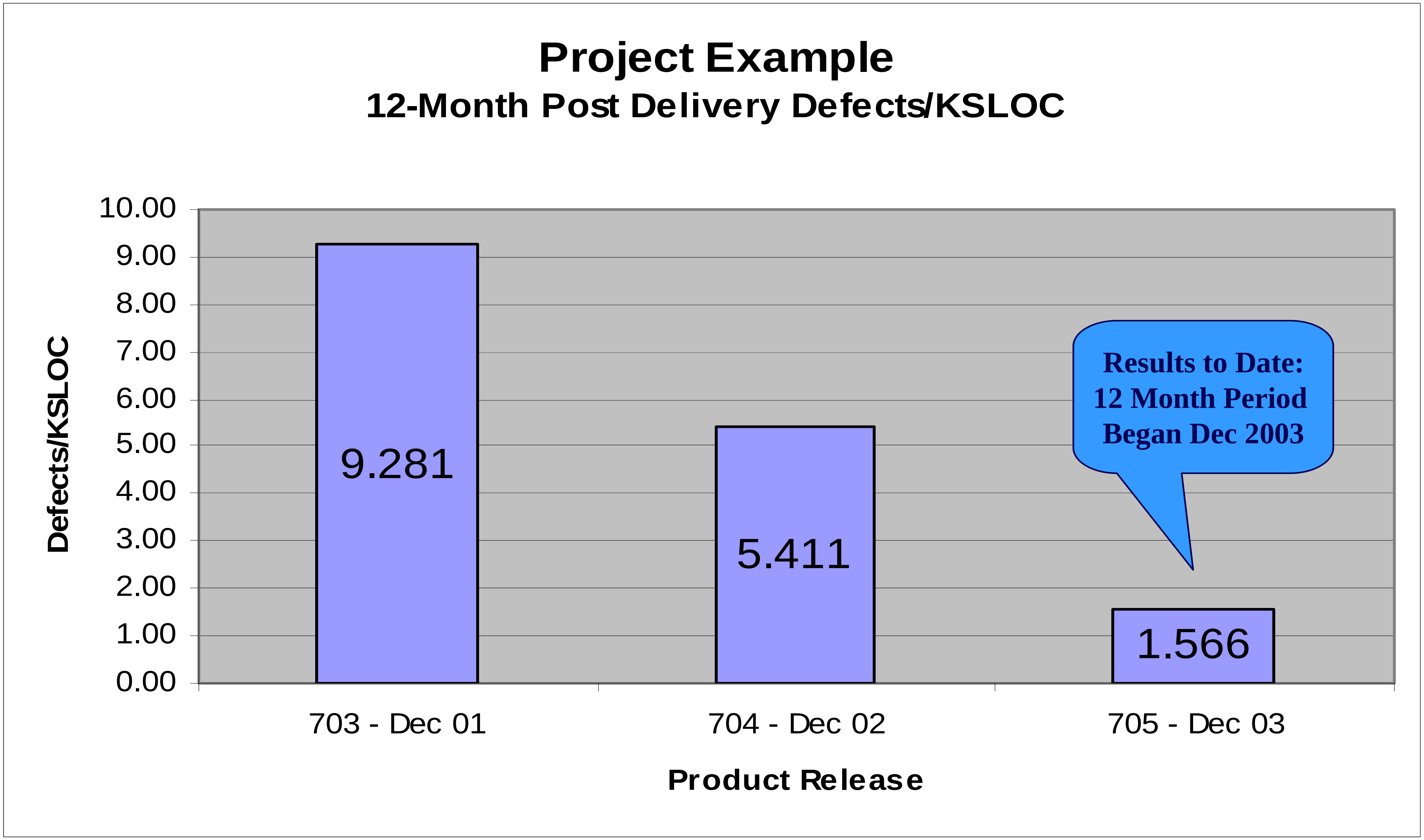
PI and Business Impacts/Value Realized

Defect Reduction



PI and Business Impacts/Value Realized

Project Example - Defect Reduction



PI and Business Impacts/Value Realized

BAE SYSTEMS

- **Functionally**
  - Integrated end-to-end project procedures
  - Aligned Business Drivers and Program Supports more closely
  - Established a process framework for internal projects throughout the organization
  - Improved internal customer relationships and teamwork

- **Organizationally**
  - Established a common architecture framework
  - Identified commonalities while maintaining unique Business model supports
  - Provided the opportunity for Organizational Business Areas to work together more effectively on common projects
  - Reduced Customer oversight in daily and annual review, audit, and product inspection activities
  - Reduced time spent preparing for audits due to customer audit avoidance and reduction in audit scope
  - Increased our competitive edge and market opportunities

- **Across the Enterprise**
  - Shared best practices implementations and lessons learned
  - Adopted a mature/proven Organizational Standard Set of Processes (OSSP) as the basis for continuous process improvement
  - Broadened the scope of continuous improvement communications

Summary

BAE SYSTEMS

- Learned from failures to emerge with an even stronger focus on continuous improvement
- Elevated process improvement importance/focus across organization/enterprise
- Recognized the need for a unified system for process improvement and quality management using CMMI for depth; using ISO for breadth
- Established an Organizational Process Group - Expansion (OPGE) that involves all Business Areas and OG relevant stakeholders
- Established ISO/CMMI regulatory panels at the OG to maintain the focus on continuous improvement
- Recognized both the qualitative and quantitative value leading to more efficient functional and project performance
- Improved our competitive edge and increased value to our customers

BAE SYSTEMS

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NORTHROP GRUMMAN
DEFINING THE FUTURE

A Project's Perspective of CMMI Level 5

5th Annual NDIA CMMI Technology Conference
2621

November 14-17, 2005

Warren Scheinin
Systems Engineer
Northrop Grumman Corporation

Agenda

Why Climb the CMMI Ladder?

Lessons Learned Along the Way

The Substantial Rewards of Operating at CMMI Level 5

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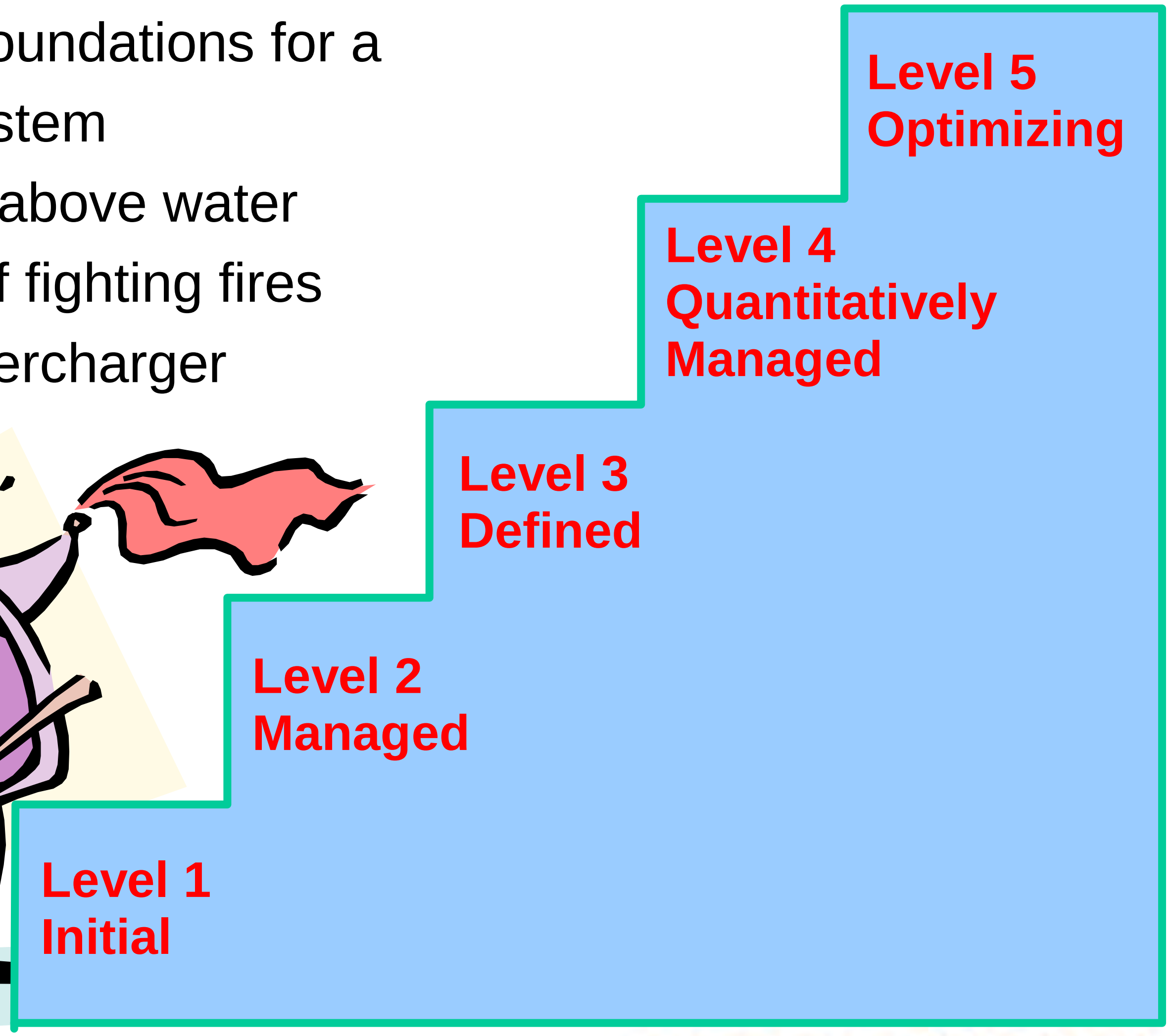
Background

- **In 2003, the Systems Development Operation organization was assessed at CMMI Level 5 in a externally-led SCAMPI-ARC A appraisal**
- **This organization is currently preparing for a re-appraisal next month**
- **This presentation examines some of the lessons learned and benefits associated with that journey**
  - New projects cannot rest on the laurels of past projects but must proactively plan for activities at all levels of the CMMI model
  - It takes time to record what's going on, but the resulting evidence is invaluable to the project

Climbing the CMMI Level 5 Ladder

- **Each CMMI Level is a step to Project Maturity**
  - Starts with the foundations for a maintainable system
  - Gets your head above water
  - Clears the fog of fighting fires
  - Engage the supercharger

The Ad Hoc Sink Hole



Level 2: Don't Throw Away the Instruction Manuals

- **Know what it is you promised to do**
- **Know what it will take to deliver what you promised**
- **Know what others promised to do**
  - Keep track of expected inputs
  - Remind suppliers of what is due
- **Start collecting data points**
- **Don't forget the past**
  - Configuration Management allows reproduction of deliverables and archives management decisions
- **Ask others for help**
  - Quality Assurance provides a check on progress and credit for accomplishments

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Level 3: Combine the Islands of Excellence Into a Functioning Team

- **Engage the software development lifecycle**
  - Follow the instructions
  - Be able to prove it works right and well
- **Take advantage of organizational assets**
  - Not invented here is still a bad idea
  - Best practices will save time and money
- **Stop drowning in the past**
  - Risk management
  - Peer reviews
- **Expand beyond your borders**
  - Include suppliers
  - Include Systems Engineering

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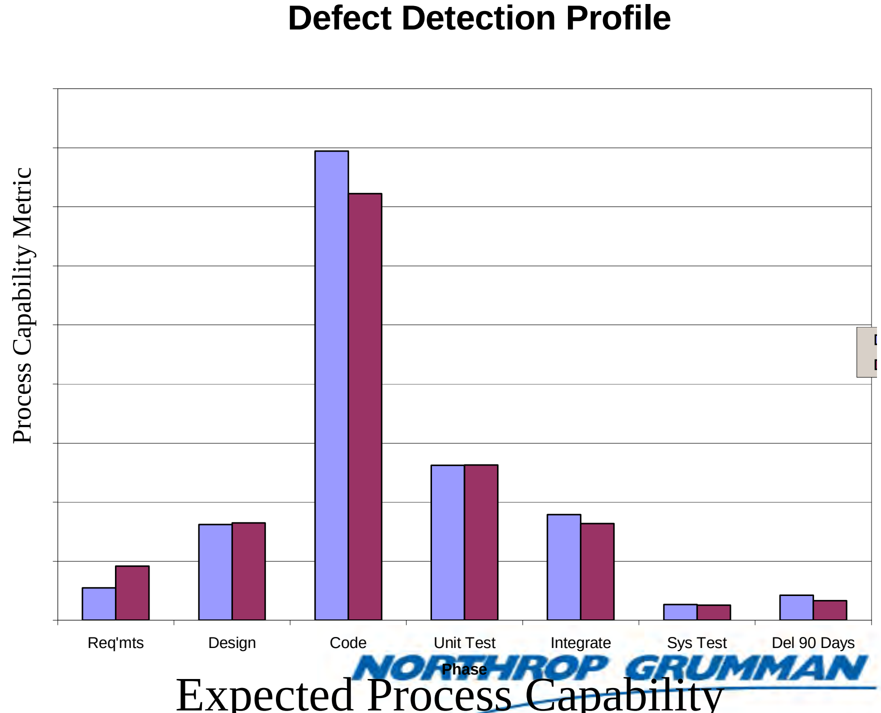
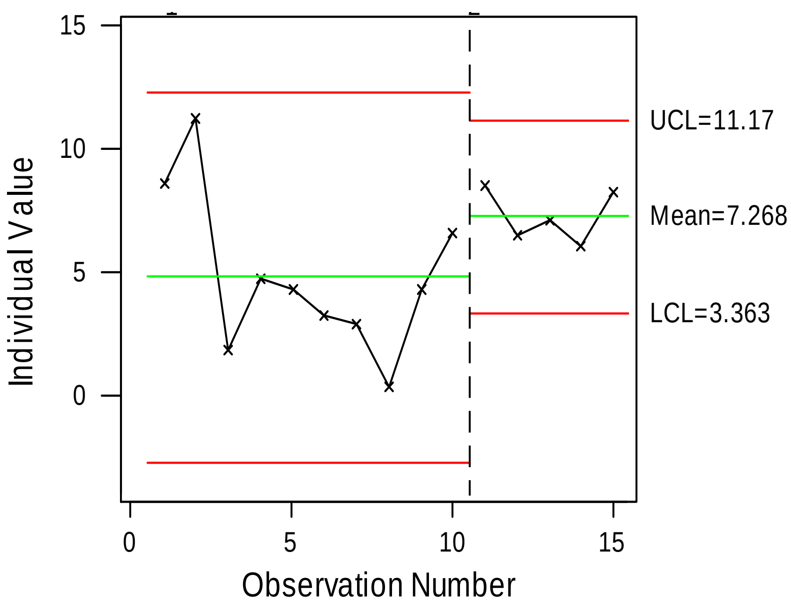
Level 4: Understand Your Processes and Subprocesses

- **Co-ordinate with other projects**
- **Take advantage of organizational knowledge**
  - Identify the implementation of processes which perform best
  - Know that processes are performing within natural bounds that are consistent across teams
  - Six Sigma
- **Level 3 metrics, measurement processes, and goal setting are generally inadequate for Levels 4 and 5**
  - Need better definitions of the measures
  - Lower level metrics of subprocesses



Level 5: Get Ahead of the Curve

- **Catch problems before they attack your project**
- **Level 3 firmly in place**
- **Reduce the variation**
  - Train people on the process
  - Create procedures/checklists
  - Strengthen process audit
- **Increase the effectiveness (increase the mean)**
  - Train people
  - Create checklists
  - Reduce waste and re-work
  - Replicate best practices



Revolutionary Process Capability Improvement

Why is Being Appraised so Difficult?

- *"The telephone is the greatest single enemy of scholarship; for what our intellectual forebears used to inscribe in ink now goes once over a wire into permanent oblivion."*

  Stephen Jay Gould

- **Finding documented evidence for a CMMI appraisal is often difficult because project performers often do not take the time to write down what they are doing**
- **The lack of written records sometimes leads to arguments about what is supposed to be happening**
- **"Just Do It" gets the job done in the short term, but written records are necessary to reap the long term benefits of operating at CMMI Level 5**

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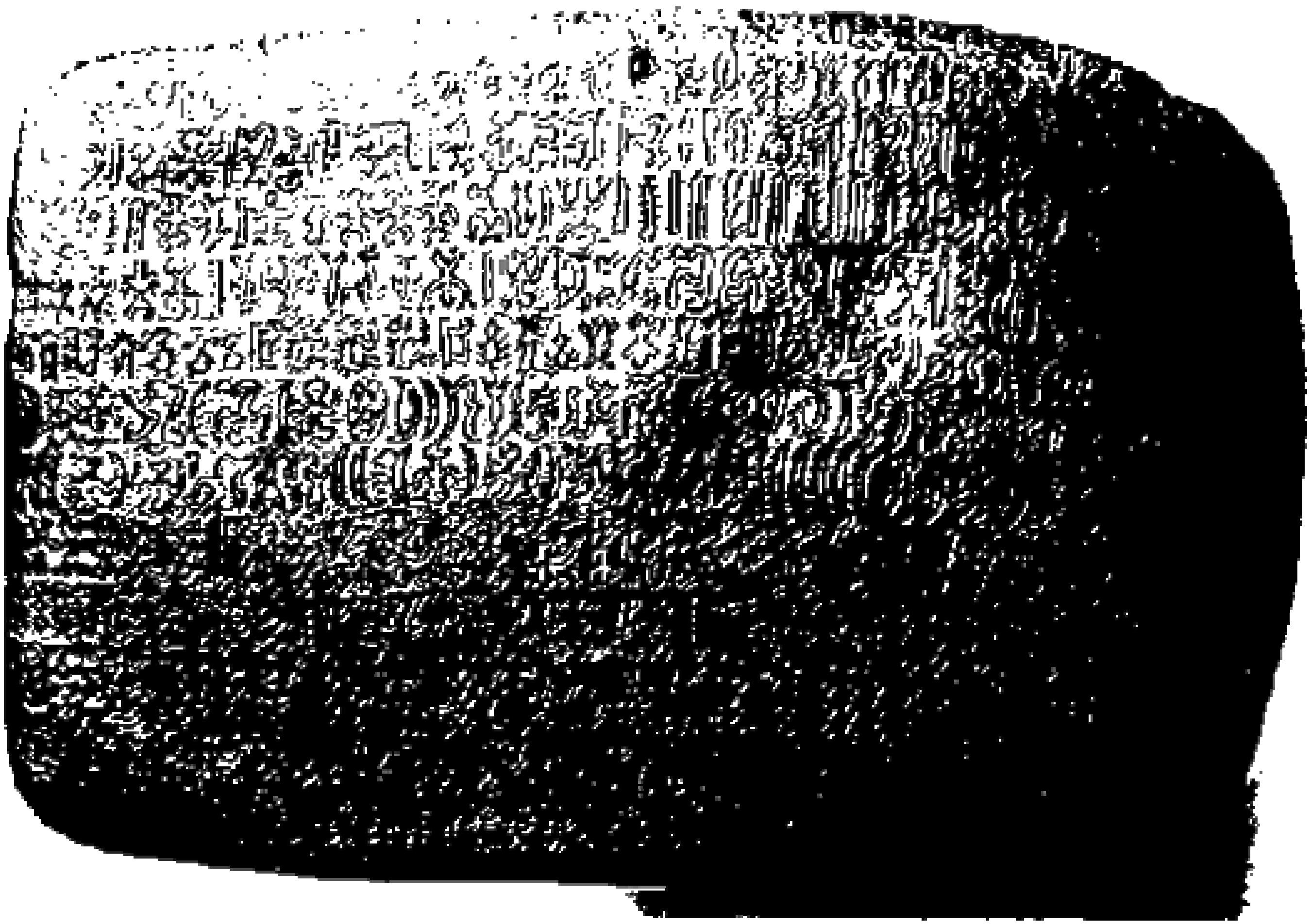
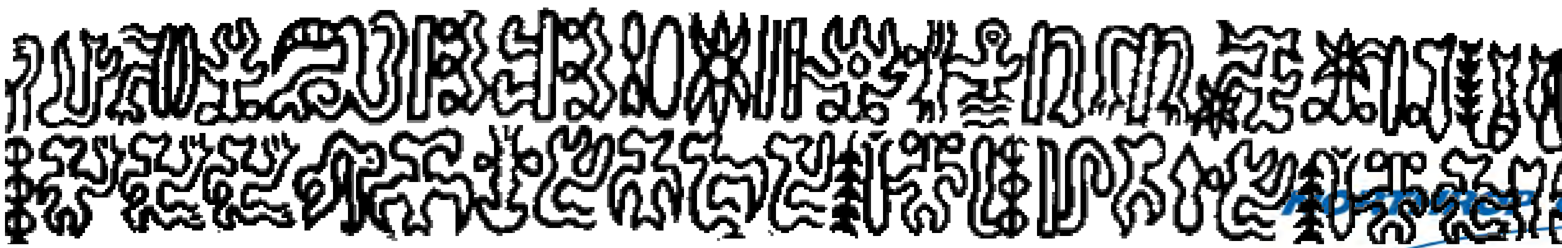
Undocumented Results Look Great But Fail to Reveal Purpose and Process

Even When Documents Are Unearthed, They Need to be Understandable





Benefits are There (If You Know Where to Look)

Organizational Dynamics

GP 2.7 Stakeholder Involvement

- Cultural dynamics did not encourage communication & collaboration across project organizations
- Permitted "stove-piped" responsibilities within software
- Project oversight not independent
- Project oversight did not recognize when program was in trouble
- Did not manage ownership by each employee
- Regressed to sell-off criteria vs. delivering a working system
- Fixing bugs took precedence over system stability
- Did not manage involvement of end-users

Validation

Continue to reinforce Project oversight & responsibility per new policy

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Benefits Materialized During the Climb

- **Instituted Weekly CMMI Coordination Working Group**
  - Collaborating with similar projects a major plus
  - Task list and schedule showed progress and encouraged participation
  - <u>Benefit:</u> Weekly meetings keep the momentum going
- **Took full advantage of upper management resources**
  - Monthly S/W Engineering Process Group (SEPG) meetings provided moral support, training, and planning
  - <u>Benefit:</u> Presentations by Process Assessment Organization lead clarified principles and showed top management commitment
  - <u>Benefit:</u> Project oversight meetings provided conduit for upper management help
  - <u>Benefit:</u> Evidence book reviews by top managers assured timeliness and quality

To Be Top-Tier is to See With New Eyes

- **Process improvement is built into the system**
  - Evidence Books used as patterns from previous appraisals were not sufficient to meet later expectations
  - Needed to add more evidence as our understanding of what makes a good process has grown
- **The culture has changed**
  - Process improvement is the object of many CAR and Six Sigma projects
  - Process people are not the first to go when budgets are cut
- **It gets easier each time**
  - Familiarity leads to quicker startup
  - Less training needed, less resistance to change

Projects Gain

- **Produced more value-added products with reduced effort and time**
  - Instead of overrunning budgets and schedules, products are delivered early and on budget
- **Needed less “help” from senior management**
- **Lots of new work began pouring in**
- **Communications with other groups was easier**
- **Meshed well with cost reduction efforts**
- **Easier to understand the role of Systems Engineering in Software Development**

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Project Leaders Gain

- **More up front thinking means less work later**
- **Fewer problems and risks along the way**
- **Improved processes added slack to cost and schedule curves**
  - Fewer replan exercises
  - Easier to give back resources
  - Easier to help other projects
- **Other projects consulted us to find out why things were going so well**

Individuals Gain

- Better understanding of how to get job done
- Less stress
- Less time doing rework
- Easier to transfer from project to project
- Easier to understand need of Systems Engineering in Software Development
- Concerns were escalated more quickly to the proper level of attention
- More enthusiastic about looking for improvement opportunities
- Down side: SPIN meetings are much less popular

Initial Resistance to Something New Faded Over Time

Our project is smaller than 10 people.

Our customer doesn't care about the CMMI.

We didn't bid the extra activities in our contract.

- **Projects must comply with both organizational policies and contract requirements**
- **Even if your customer is not familiar with CMMI, they will appreciate the benefits:** CMMI practices **save** the customer **time and money**
- **Adopting the CMMI is a cost of doing business and is included in the services we provide our customer to assure quality products**
- **Other benefits**
  - **Less rework -> nights, weekends and holidays off**
  - **Discussions lead to "Ah Ha's", "I thought…", "Oh, I didn't know…"**
  - **No surprises - the customer becomes your friend**

Summary – Project's Perspective of CMMI Level 5

- Much of the hard work in establishing a foundation is past with significant benefits
- Level 5 project activities put available information to use in identifying project improvement opportunities
- Innovative process improvements are readily available for implementation
- The project, management, and individuals realize real benefits from Level 5 operation

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DEFINING THE FUTURE

Ways to Ensure the Culture Supports Level 5

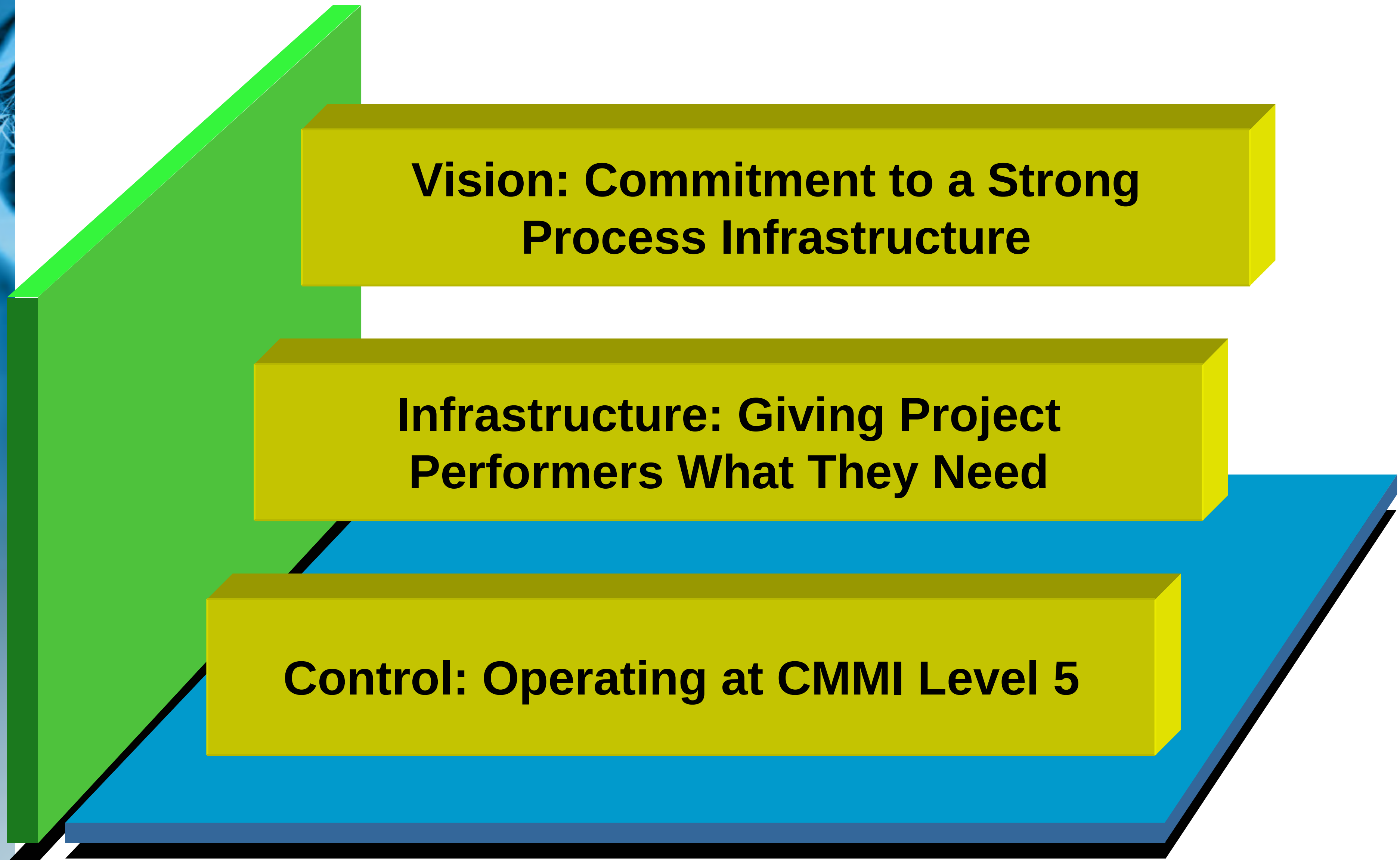
5th Annual NDIA CMMI Technology Conference

2623

November 14-17, 2005

Warren Scheinin
Systems Engineer
Northrop Grumman Corporation

Agenda – Three Components of a Culture That Supports Projects At CMMI Level 5



Background

- **In 2003, the Systems Development Operation organization became another of over 16 NGC organizations assessed at CMMI Level 5 in externally-led SCAMPI-ARC A appraisals**
- **This organization is currently preparing for a re-appraisal next month**
- **This presentation examines some of the cultural components that made this journey a success**
  - Organizations must provide vision and encouragement to project to reach CMMI L5
  - The organizational infrastructure must support and guide the projects to CMMI L5 performance
  - Organizations must control and maintain the forward drive and infrastructure

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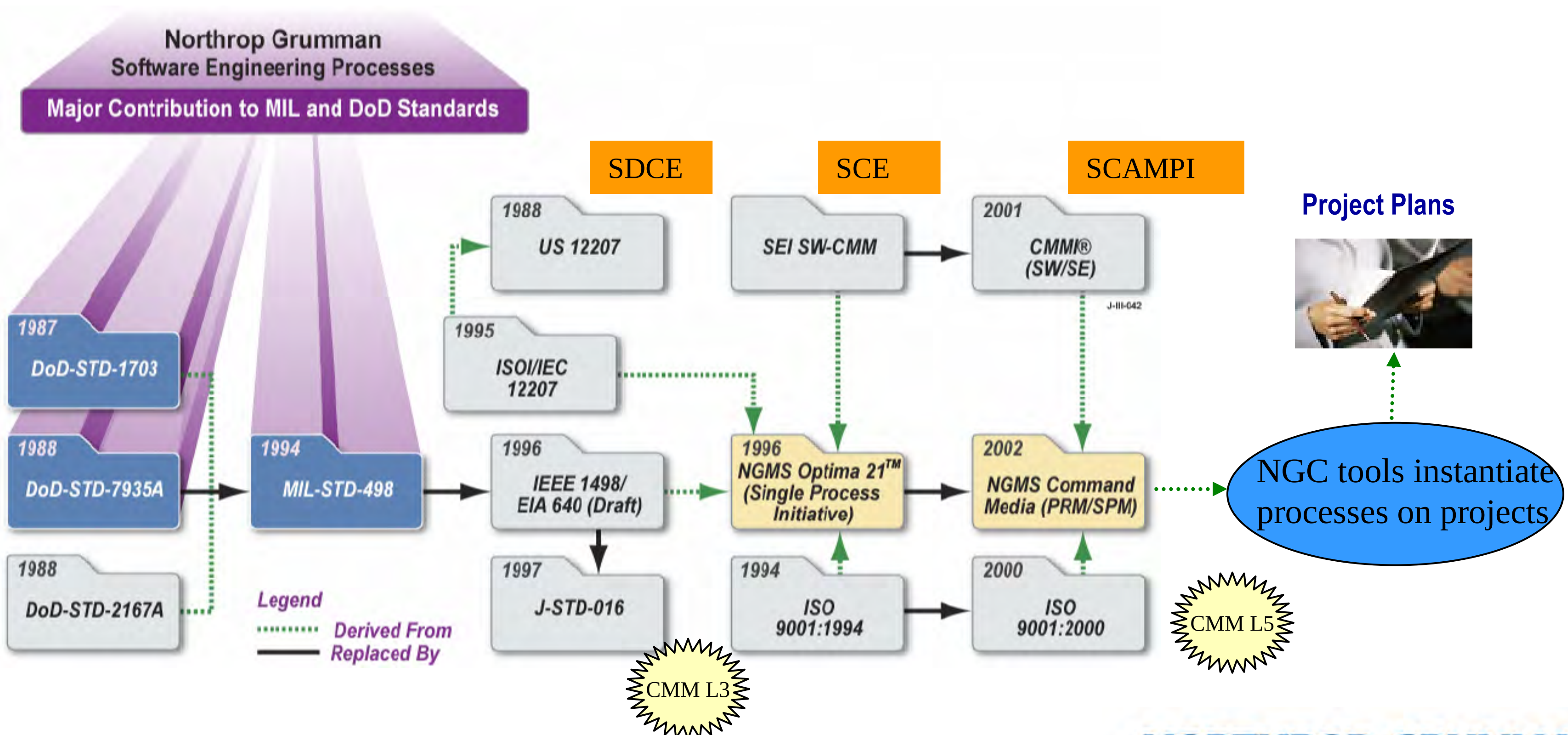
Northrop Grumman Has Evolved A Strong Process Infrastructure

- **The NGC Process Infrastructure is built on the corporate commitment to managing programs in a deterministic way to delivery high quality products at lower costs**
- **New programs inherit the NGC process as part of project startup**



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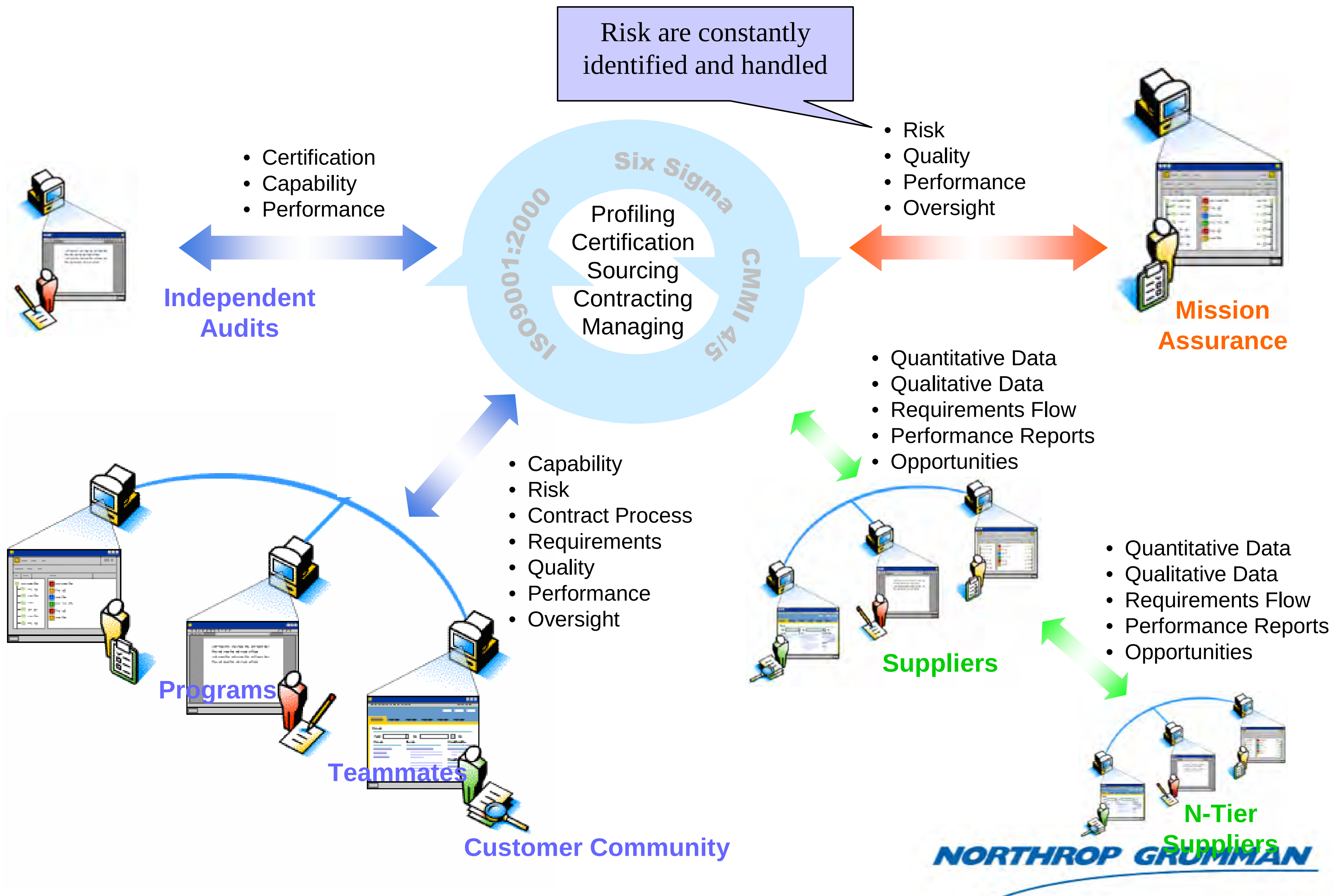
NGC Process Structure is Integrated with Teammates and the Customer



Organizational Gains

- Organizational and Customer goals are flowed down to project goals.
- Stove piles are replaced with continual stakeholder involvement
- Concerns are escalated more quickly to the proper level of attention
- Less “help” needed by projects from senior management
- Easier to transition personnel from one project to another
- Less firefighting, more emphasis on delivering consistently high quality products and services that meet the customer’s needs
- Strong program performance to budget and schedule; lower risk, higher quality

A Culture is a Way of Doing Business

- **Clear Vision instilled in goals and plans**
  - CMMI and Six Sigma practices are being institutionalized as the normal "way of doing business"
  - Tied to strategic goals and led by management
  - Widespread involvement and buy-in at all levels
- **Common infrastructure across the sector**
  - One set of policies, process descriptions, metrics, training
  - Allows for common enterprise-wide, minimizes costs and promotes best practice sharing and adoption across the organization
- **Disciplined configuration management, evaluation and dynamic improvements for increasing capability**

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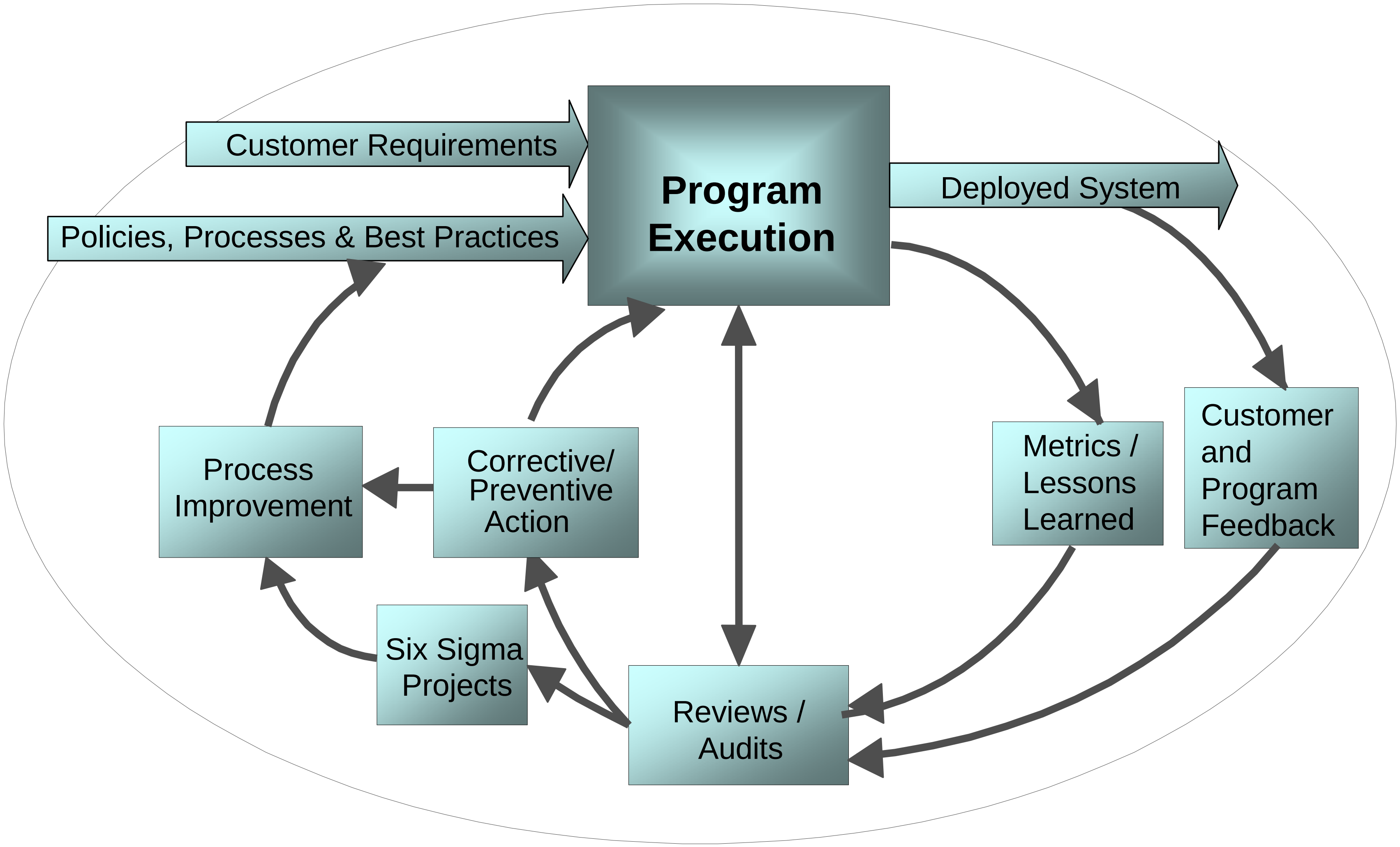
Mission Success Realization System

A program execution system based on proven enterprise policies and processes . . .



. . . operating in a closed-loop system aimed at Mission Success

Characteristics of an Effective CMMI Culture

- Well-defined Authority, Roles, and Responsibilities
- Strong, effective infrastructure with closed-loop feedback and controls
- Flexibility to meet needs of different program types and degrees of application
- Independent review and reporting functions
- Well-qualified workforce able to manage and execute aspects of CMMI at all levels in the organization
- Evaluation, appraisal, improvement and configuration management of artifacts
- Commitment to performance excellence from all levels of the organization
- Commitment to customer satisfaction

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Authority, Roles, and Responsibilities Starts with Senior Management

- **Organization Leadership sets the cultural tone**
- **Senior management commitment is key to CMMI achievements**
  - Many competing initiatives
  - Authority defined at all levels of organization
  - Stakeholder roles and responsibilities defined
- **Meetings keep the momentum going**
  - Need to keep stakeholder engaged
  - Software/Systems Engineering Process Group
- **Communication**
  - Web sites
  - Emails – a blessing and a curse

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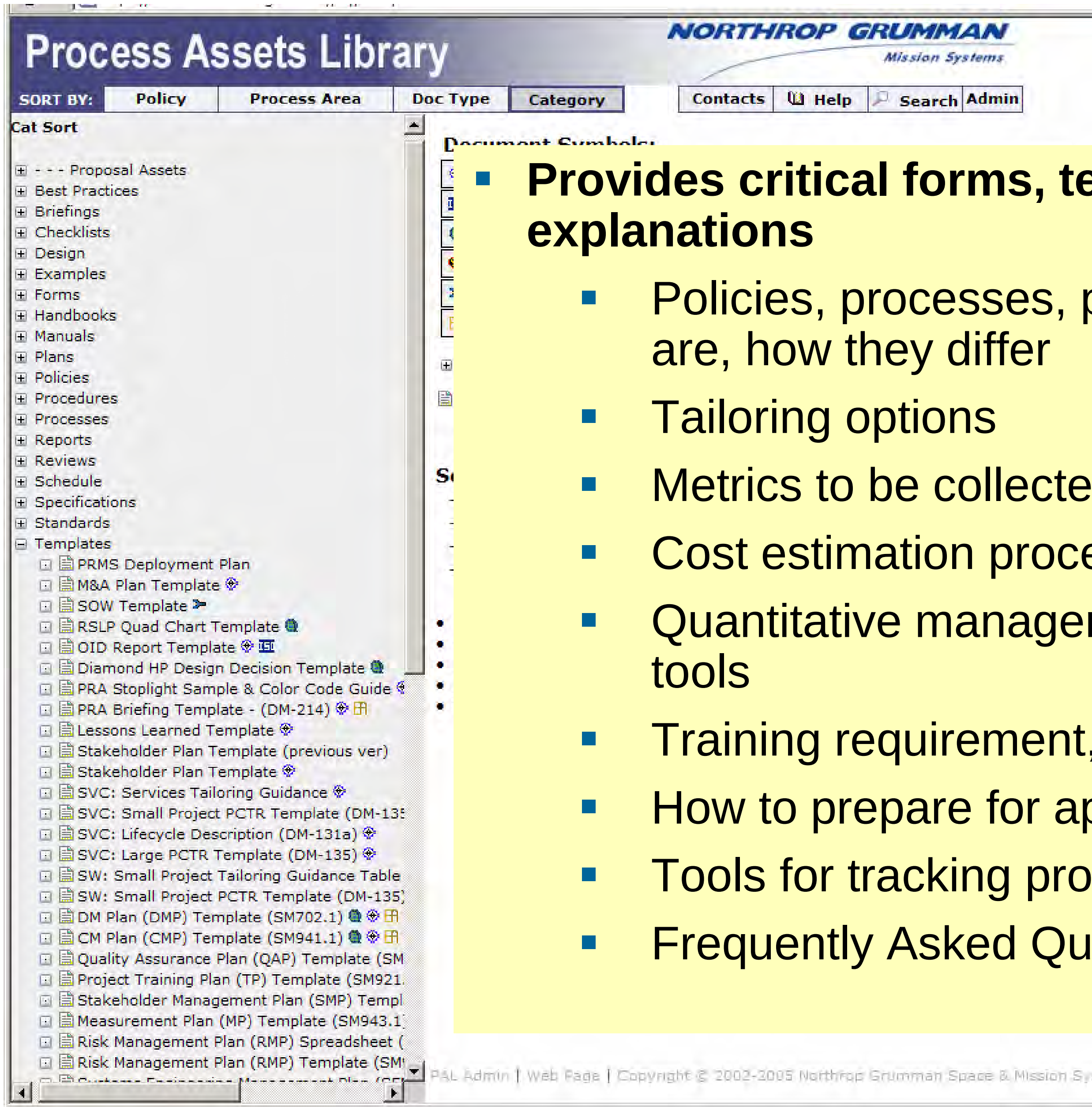
Strong, Comprehensive Infrastructure Supports the Culture

- Organizational Policies and Procedures cover all aspects of mission success and engineering
- Training provides skills and acceptance
- Organization standard processes allow uniform project processes
- Comprehensive Measures/Metrics system provides estimates, track progress and allow comparisons
- Process Assets Library speeds up the spread of the culture
- Lessons Learned database prevents errors
- Independent SQA reporting path
- Senior management review

Web Based PAL Gives All Performers Easy Access To What They Need



- **Provides critical forms, templates, and explanations**
  - Policies, processes, procedures – what they are, how they differ
  - Tailoring options
  - Metrics to be collected, how they are used
  - Cost estimation processes and tools
  - Quantitative management processes and tools
  - Training requirement, materials
  - How to prepare for appraisals
  - Tools for tracking progress
  - Frequently Asked Questions

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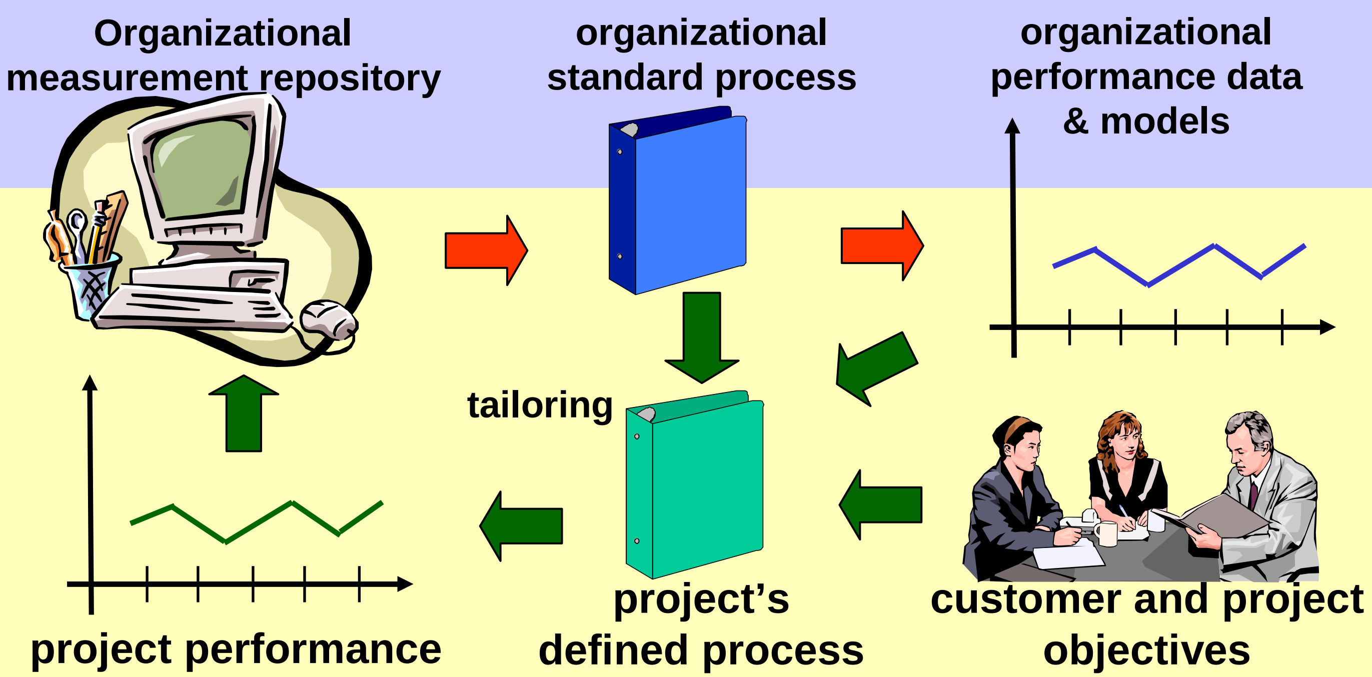
Organizational Process Capability dB Fuels the Metrics System with Vital Feedback

- **Organizational Process Performance**
  - Establishes a quantitative understanding of the performance of the organization's set of standard processes
  - Provides process performance data, baselines, and models to quantitatively manage the organization's projects

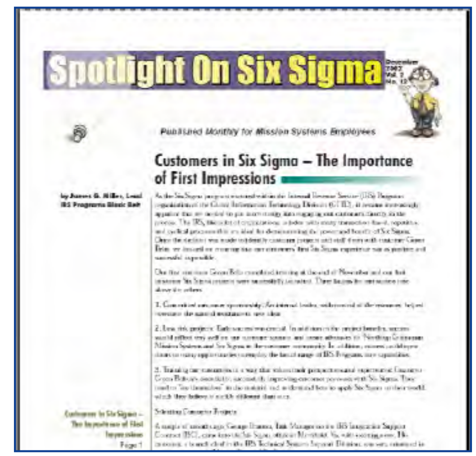


Web Site Makes Best Practices and Break Through Improvement Readily Available

Six Sigma Website

StartIt!
Project Database

Green Belt Primer



Monthly Newsletter

Six Sigma on-line resources keep employees informed and knowledgeable.

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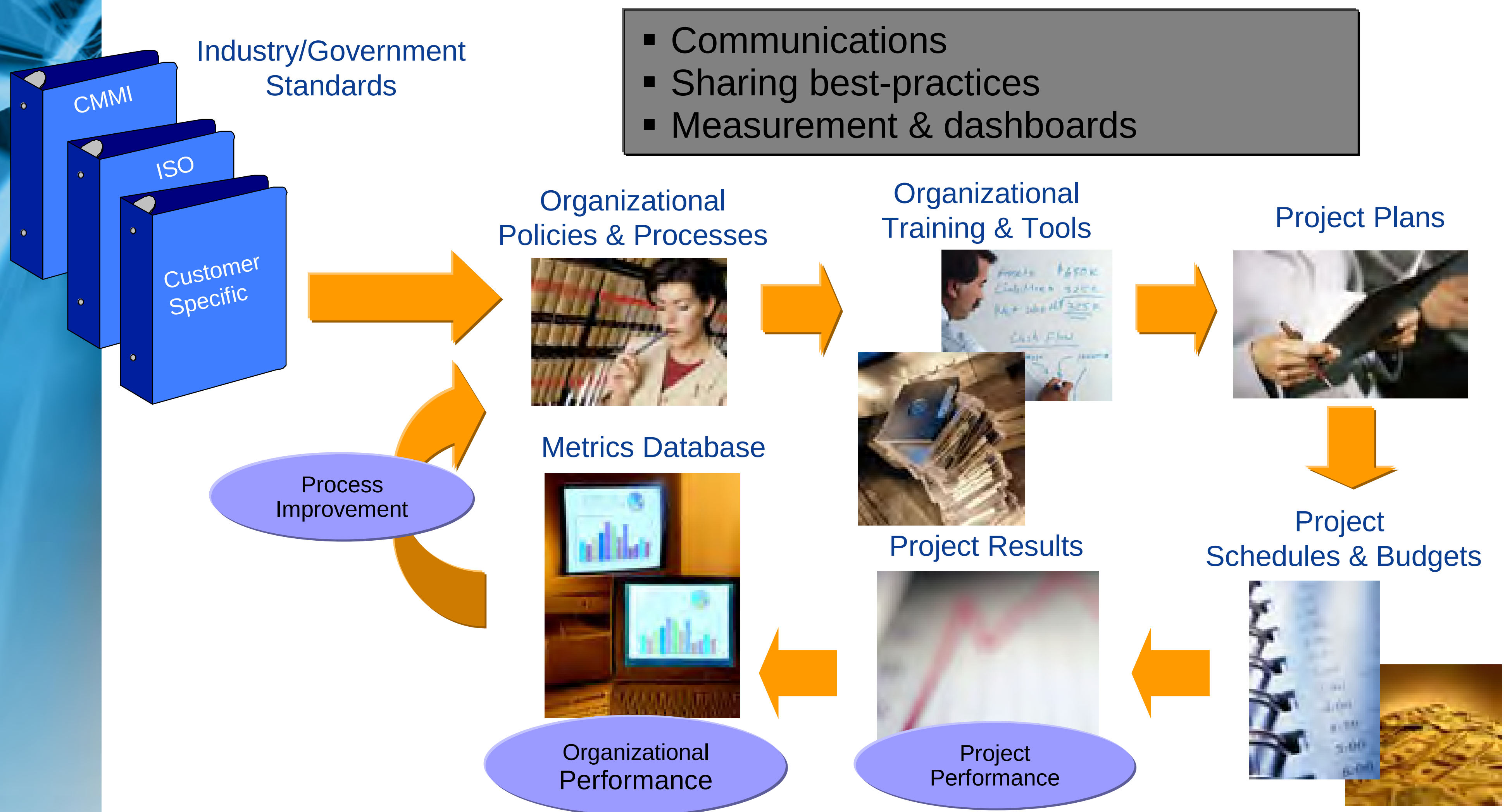
Putting it All Together: Institutionalizing the Improvements in a Closed Loop System



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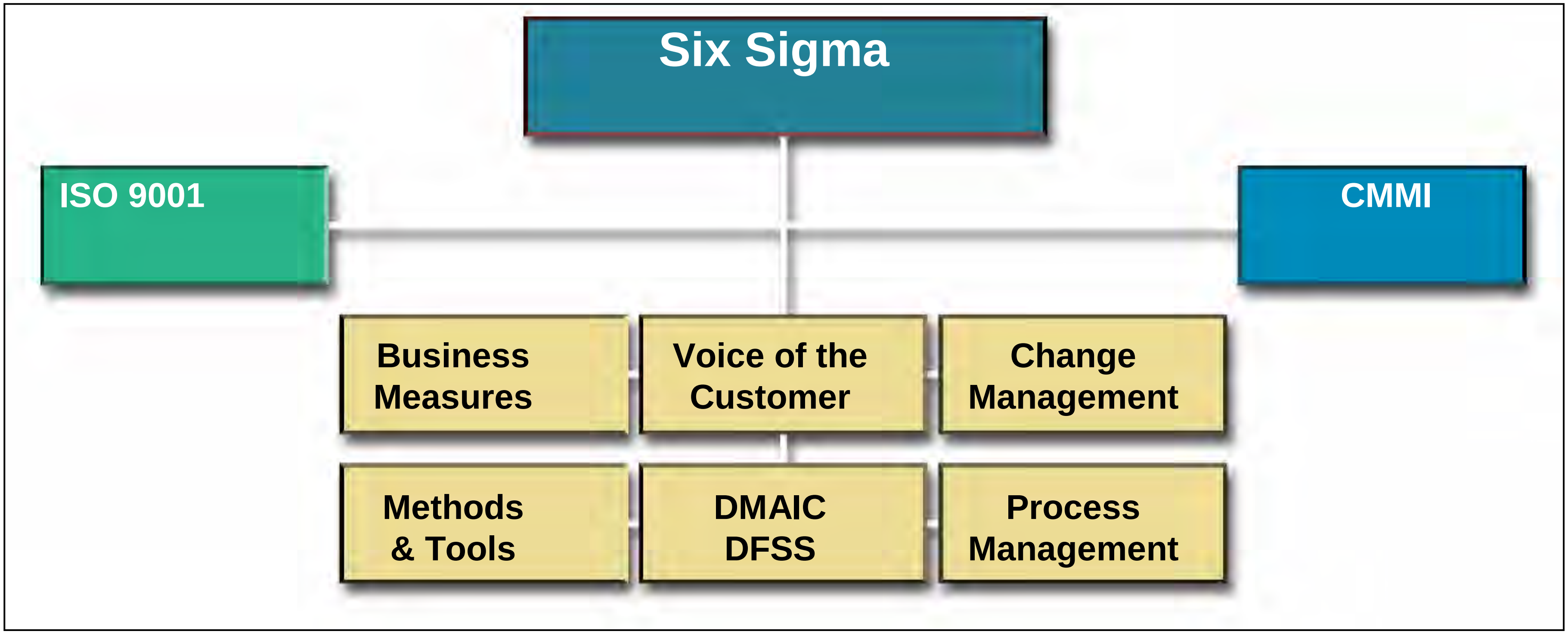
Mission Systems' Integrated Approach to Process Improvement



ISO 9001 – quality management discipline for project and functional areas

Six Sigma – framework for ensuring process improvements support corporate goals

CMMI – use of industry best practices in software/systems engineering

Flow Down to Projects

- **Instituted Weekly CMMI Coordination Working Group**
  - Collaborating with fellow contracts a major plus
  - Benefit: Weekly meetings keep the momentum going
- **Took full advantage of Division resources**
  - Management sponsorship was essential to success
  - Monthly SEPG meetings provided support group, training, and planning
  - Benefit: Presentations by Process Assessment Organization lead clarified principles and showed top management commitment
  - Benefit: PRA meetings conduit for upper management help
  - Benefit: Evidence book reviews by top managers assured timeliness and quality

Institutionalization Includes Training All Personnel

Module	Test (Download File Locally)	Standard Training Module	Revis
		700 MISSION SUCCESS	
STM 700.0	STM 700.0	Policies and Processes Awareness	Rev 08, 0
STM 700.1	STM 700.1	CMMI Awareness	Rev 02, 0
		720 QUALITY SYSTEM	
STM 723.0	None	Introduction to Documents and Records Control	Rev 08, 0
STM 723.1	None	Documents and Records Control	Unavail
		730 PROCESS MANAGEMENT	
STM 731.0	None	Introduction to Organizational Process Definition	Rev 07, 0
STM 731.1	None	Organizational Process Definition	Rev 03, 0
STM 732.0	None	Introduction to Organizational Process Focus	Rev 07, 0
STM 732.1	None	Organizational Process Focus	Rev 03, 0
STM 733.0	None	Introduction to Organizational Process Performance	Rev 07, 0
STM 734.0	None	Introduction to Organizational Innovation and Deployment	Rev 07, 0
STM 735.0	None	Introduction to Organizational Training	Rev 08, 0
STM 735.1	None	Organizational Training	Rev 03, 0
		910 Acquisition	
STM [illegible]1.0	None	Introduction to Start-up Planning	Rev 05, 0
		920 Project Management	
STM 921.0	STM 921.0	Introduction to Project Planning	Rev 08, 0
STM 921.1	STM 921.1	Tailoring	Rev 07, 0
STM 921.1	None	Tailoring Handout	Rev 01, 0
STM 921.1	None	Tailoring (Remote Students Only)	Rev 00, 0
STM 921.1	None	Tailoring (For Demo Only)	Rev 05, 0
STM 921.2	STM 921.2	Project Planning	Rev 05, 0
STM 921.3	None	Software Cost Estimation Overview	Rev 02, 0

Covers all CMMI Process Areas

Includes how to tailor **Organizational Policies & Processes** to project use.

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In Process Support

- **Internal assessments**
- **External assessments**
- **Monthly SSEPG meetings**
- **Library of assets**
- **Support to projects to identify/explain organizational best-practices**
- **Support from senior management**
  - Set goals
  - Integrate with other initiatives

Evaluations – Total Life Cycle Performers Need Help, Easy Access to Results

Focus on the WHAT , the WHEN then the WHO (FUNCTIONAL OWNER). Pretend/operate as if this line is missing !

Pre-Award

Continued process performance

- **Gate Reviews Cover**
  - **Requirements Feasibility**
  - **Schedule**
  - **Technical**
  - **Cost/Profit**
  - **Past Performance**
  - **Supplier Select./Past Perf**
  - **Process**
  - **Mission Assurance**
  - **Cash Flow**
  - **Risks/Costed**
  - **Lessons Learned**
- **Non-Advocate Review**
- **Independent Cost Evaluation**

Project Execution

Improved process performance

- **Performance Reviews Cover**
  - **Requirements Management**
  - **Schedule**
  - **Technical**
  - **Cost/Profit**
  - **Customer Satisfaction**
  - **Subcontract Performance**
  - **Process Health**
  - **Mission Assurance**
  - **Cash Flow**
  - **Risks/Costed**
  - **Lessons Learned**
- **ISO Findings and Corrective Actions**
- **CMMI Assessments**
- **Metrics from Project Reviews**
  - **Risks/Costed Risks**
  - **EVM**
  - **Defects (HW/SW)**
  - **Subcontract Report Cards**
- **Independent Risk Reviews…**

Next Opportunity

- Pre-award
- Project Execution
- Pre-award
- Project Execution

Assessment and evaluation are continuous activities

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We Have Optimized Appraisals

- **We assess in half the time of the industry average**
  - Every project rated against every CMMI practice
- **Appraiser experience is key**
  - Appraisal teams are 6-9 people – over half the team members must be experienced
  - Documented standards for interpreting sufficiency
- **Preparation and automation reduce appraisal cost and time**
  - Projects assemble evidence in advance
  - Standard interview questions; templates for appraisal plan, all presentation
- **<u>Benefit:</u> Guidance and support from Organizational appraisers save projects time and frustration**

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Summary

- **An effective CMMI L5 culture:**
  - Supports the organization's Vision to build a foundation to deliver consistently high quality products and services that ensure mission success
  - Enhances the customer's confidence that projects have the Infrastructure needed to meet/exceed contract requirements and mission needs
  - Provides the Controls needed to quantitatively manage and enhance project process improvements and excellence

Ensures the discipline necessary in an environment of highly-complex, mission-critical systems through vision, infrastructure and control.

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Raytheon
Customer Success Is Our Mission

Keeping the Team Motivated for Success

Raytheon Missile Systems

Mike Scott and Mike Notheis

November 2005

Introduction

Raytheon
Missile Systems

Process initiatives are hard and so is attracting and keeping talented people for the duration.

- This presentation discusses RMS's approach to:
  - Setting the goal and vision
  - Team building
  - Rewards and recognition
  - Achieving success

How do you get over 95% of a team wanting to stay on for the next process initiative?

Setting The Goal & Vision

- Leadership must set the goal and the vision for the initiative
  - The initiative was about improving the enterprise and the way we do business
    - This was reinforced throughout our 18 month quest
  - Leadership established RMS wide goals
    - Business goals
    - Program performance goals
    - Process improvement goals

Set the vision and the goal

Develop the Plan & Focus the Task

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Missile Systems

- Exactly what tasks need to be done – Critical Chain Mgmt.
- Executive Manager – Reports directly to Business President and Executive Team
- Program Manager – Chief Barrier Remover
- Chief Engineer – Lead the Technical Accomplishment
- The Team – Let them do what they do best - Accomplish

Define the roles and responsibilities

Alignment is a Key

- Management Team met at 7:30 Each Morning – 15 to 30 Minutes
- The entire team met every morning at 8:00 for a 15 to 30 Minute Stand-up
- The Stand-up centered on the Critical Path only – Identification and removal of barriers

Daily communication to keep on track

Building The Team

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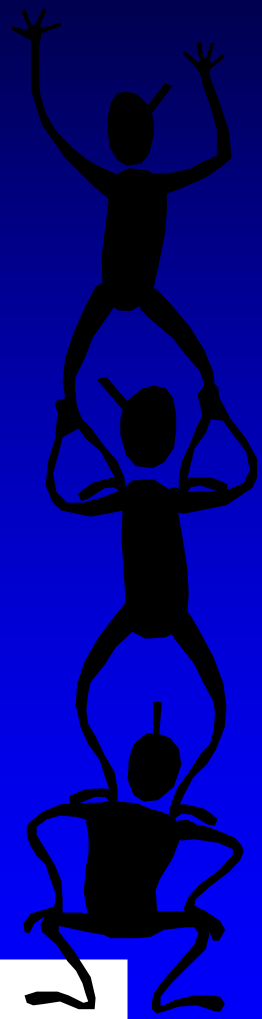
Missile Systems

- Leveraged process expertise from our software community
  - These folks seeded our team
- We needed a lot more people power
  - Solicited support from all engineering and support organization disciplines
  - Raided our Six Sigma organization
  - Our team grew to 60 full-time people
    - Highly motivated individuals
    - People who were dragged in
    - Everything in-between



Next you need resources

Developing the CMMI Knowledge

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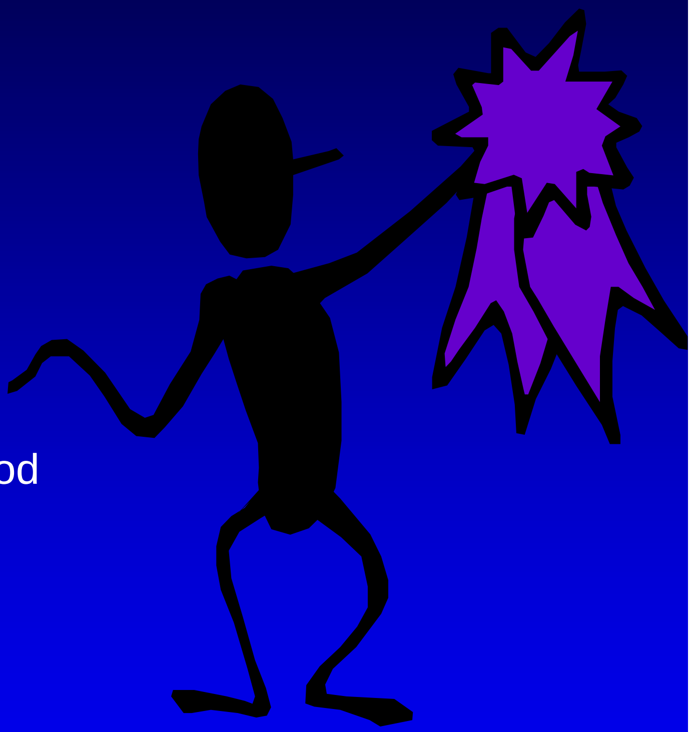
- Most of the team knew nothing about CMMI
  - Established an extensive training plan on the model
  - Assigned two-person teams to each process area
    - Workshops held
    - Shoulder-to-Shoulder reviews
  - Process Area experts cross-trained rest of the team
  - Engaged our external appraisal team early and often to leverage their expertise

Now you need knowledge and experience

Raytheon Missile Systems

Rewards

- Rewards must be meaningful
  - We used typical rewards
    - Merit and promotion
    - Team awards
    - Individual achievement
  - We also used alternative rewards
    - Gift certificates to the local mall (on the spot)
    - Maintained a "snack shack" with drinks and junk food
    - Handed out badge lanyards, team shirts, etc.
  - We rewarded in other ways
    - Conference and seminar attendance
    - Briefing to executive leadership opportunities
    - Expanded responsibilities



Reward great performance often

Recognition

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- Got to know our team as individuals
  – What is going on in their lives
  – What stresses are they under that could affect performance
  – What motivates and de-motivates them
  – What will challenge them and what will overwhelm them

- Publicly celebrated team and individual success
  – Daily stand-up sessions to share status and information
    Applauded every task completion
    Celebrated every birthday
    Thanked the individual and team for each success
  – Luncheons to celebrate milestones achieved

Recognize people in open forums

Achieving High Performance

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- Valued high performance and success at team and individual levels
  - Focused on results
    - Individual
    - Team
  - Treated "people as people"
- Created an environment for success
  - Respect for one another
  - Simple amenities
  - Effective rewards and recognition

PEOPLE will make you successful

The Results

- Built a high performing team quickly that met all initiative milestones
- Achieved our ultimate goal on-schedule and under-budget
- An easy team to manage
- Over 95% of the team members expressed their desire to stay together as a team

How do you get over 95% of a team wanting to stay on for the next process initiative? – Treat people as people!

Raytheon
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"Barrier Busting" – Obtaining Active Leadership Support

Raytheon Missile Systems
Mike Scott & Eric Ziegler

November 2005

Introduction

Raytheon
Missile Systems

Barriers impede performance. Having the right environment that focuses on the removal of these barriers can help ensure success.

- This presentation addresses:
  - Establishing and communicating clear goals
  - Having the right sponsors in the game
  - Setting up a leadership structure that works
  - Constant communication to all the stakeholders
  - Having a team that is focused on success

To maintain speed and agility you must identify and remove barriers quickly

Clear Goals

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Missile Systems

- Executive leadership set measurable goals and a vision for our process initiative
  - The initiative was about improving the enterprise and the way we do business
    - This was reinforced throughout our 18 month quest
  - Enterprise wide goals
    - Business goals
    - Program performance goals
    - Process improvement goals

- Goals socialized and accepted throughout the organization

Clearly communicated goals get everyone on the right road

Sponsorship

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- Site President
  - Set Vision and Goal
  - Quarterly Reviews
  - Weekly with the Executive Interface
- Executive Advisors Group
  - VPs from Engineering, Quality, Finance, Operations
  - Twice monthly reviews
- Executive Interface
  - Full-time assignment to the team
  - Chief Barrier Buster

Participatory Sponsorship is crucial

Leadership

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Site President

Sets the vision and goals. Breaks down **ENTERPRISE BARRIERS**.

Executive Advisors

Provides guidance and direction. Breaks down **ENTERPRISE BARRIERS.**

Executive Interface

Provides interface to enterprise executives. Breaks down **ORGANIZATIONAL BARRIERS**.

Program Manager

Makes programmatic decisions and direction. Breaks down **PROGRAM BARRIERS.**

Chief Engineer

Responsible for all technical decisions and direction. Break down **TECHNICAL BARRIERS**.

Leadership sets the expectation and must provide the behavior example for the team

Communication

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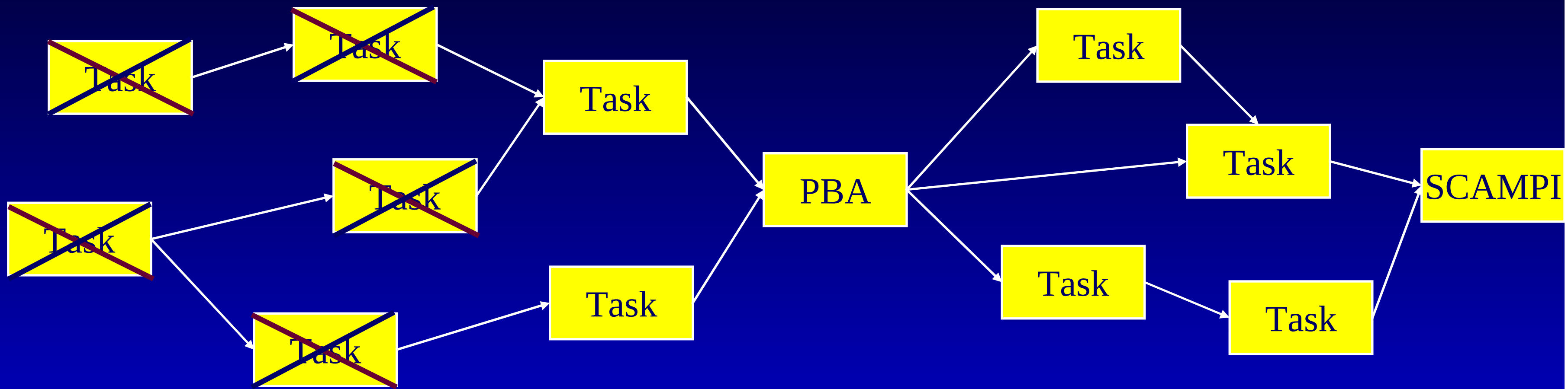
- Up
  - Quarterly with Site President
  - Twice monthly with Executive Advisors Group
  - Daily with Executive Interface
- Across
  - Twice monthly Program Manager Lunch
  - Twice monthly Functional Manager breakfast
  - Deployment leads assigned to each focus program
- Down
  - Weekly information sharing
  - Daily status and barrier identification/removal

Constant and clear communication keeps everyone vectored in the same direction

Team Focus



- Detailed plans at the task level focus the team
- Daily Stand-ups
  - Status completions
  - Identify risks
  - Identify/resolve barriers (everyone felt comfortable bringing issues to the table)
  - Immediate corrective action
  - Meaningful, daily metrics

A team that is focused on results will be successful

Raytheon Missile Systems

The Results

- Identification and removal of barriers was issue focused not punitive
- We all owned and participated in Barrier Busting
- No barrier remained on the list for more than a week
  - Nearly all resolved in the same day
- Empowered Teams that learned to break down their own barriers
- Achieved all initiative goals on-schedule and under budget

To maintain speed and agility you must identify and remove barriers quickly

Enterprise Process Integration within the Space and Airborne Systems Business Area of Raytheon

Linda Kovar

and

Deana Seigler

November 16, 2005

Setting the Stage

Raytheon Space and Airborne Systems

- **Raytheon is an industry leader in defense and government electronics, space, information technology, technical services, and business aviation and special mission aircraft.**
  - **The company is divided into seven major business units**

- **Space and Airborne Systems (SAS) is one of the seven business units that make up Raytheon**
  - **Conglomeration of programs from various legacy defense companies such as Hughes Aircraft, Texas Instruments and Raytheon Company**
  - **2004 Revenue of $4.1 Billion**
  - **13,000 employees**
  - **4 geographic locations**
    - **El Segundo, CA**
    - **Goleta, CA**
    - **Texas**
    - **Mississippi**

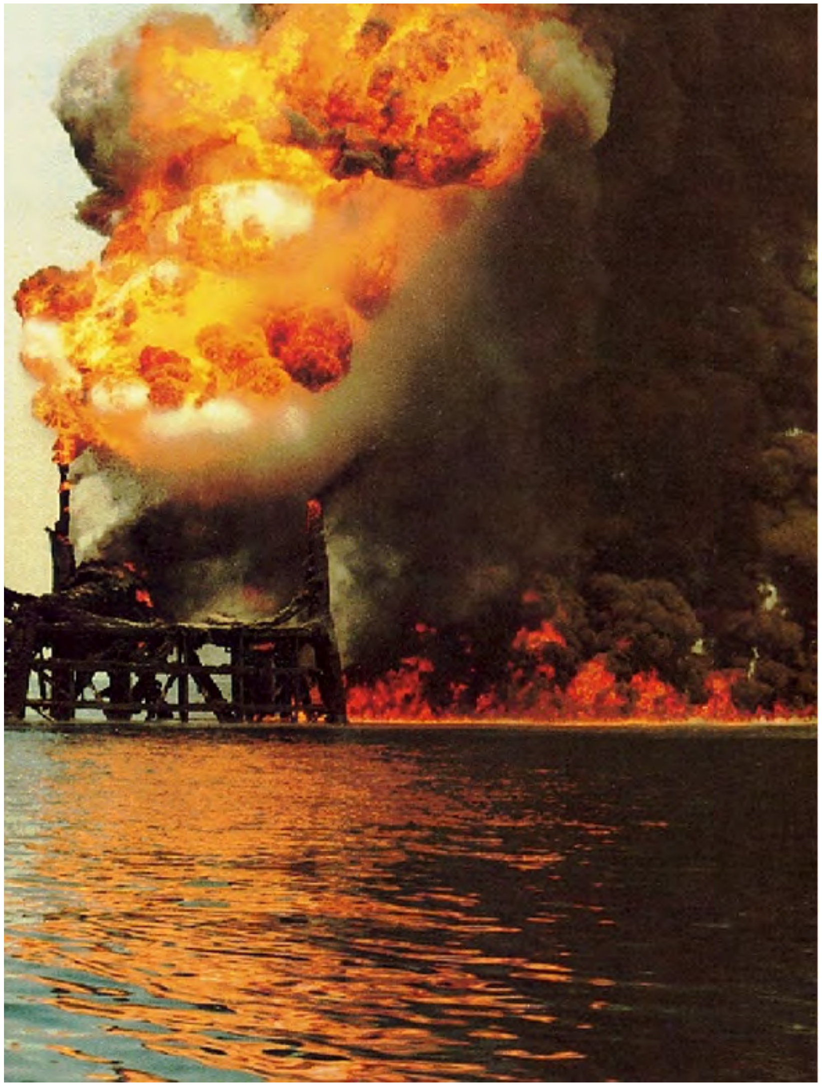
Setting the Stage

- **Each location had their own set of processes, process improvement initiatives and goals**
  - **El Segundo had been previously assessed at CMMI Level 3 for Systems and Software Engineering**
  - **Texas had been previously assessed at CMMI Level 5 for Software Engineering and CMMI Level 3 for Systems Engineering**
- **At the beginning of 2004, there were three sets of processes being developed and maintained within SAS**
  - **Separate process groups working independently**
    - **Site specific**
    - **Discipline specific**

SAS EMS ENTERPRISE SOLUTION

Case for Action

Raytheon
Space and Airborne Systems



- **Increasing business need to share work between geographic locations**
- **Discipline-specific processes existed for Systems, Software, and Hardware Engineering**
  - **Across the sites we found we had separate but similar processes**
  - **As Hardware Engineering started down the process improvement journey, we realized many of the same processes would be needed**
- **Multiple CMMI appraisals would be needed and were planned due to the varying processes and goals**

SAS EMS ENTERPRISE SOLUTION

The Goal

Raytheon Space and Airborne Systems

- In July 2004, Jack Kelble, SAS President, made the strategic decision to integrate development processes across SAS
  - El Segundo already had a process architecture called the Enterprise Management System (EMS)
  - Only the El Segundo processes were integrated into this architecture
- Goal was to achieve CMMI Level 5 for Systems and Software Engineering and CMMI Level 3 for Hardware Engineering in 2005
  - As part of this goal, all engineering development processes were to be merged and integrated into EMS
  - In addition, one CMMI Class A appraisal was to be conducted for the entire SAS organization

Plan of Attack

- Execute this enterprise process integration effort like a program
- Determine an approach that would allow SAS to integrate processes across the entire organization in a very short period of time
- Develop a proposal describing how to accomplish the goal and identifying what resources would be required

Look for better solutions!

- Pull the “best of the best” processes from across SAS to form the SAS standard process
- Create discipline-independent processes whenever feasible

Plan of Attack

- Organize several teams to develop the plan to integrate the processes across the enterprise
  - Core Proposal Team
  - Numerous Mini-Teams
  - Management Review Team

- Create a unified Enterprise Process Group (EPG) for all sites and disciplines
  - Ensure representation from all sites on all teams and throughout the EPG Leadership Team
  - Reduce process improvement effort by maintaining only one set of processes and conducting a unified appraisal

SAS EMS ENTERPRISE SOLUTION

Core Proposal Team

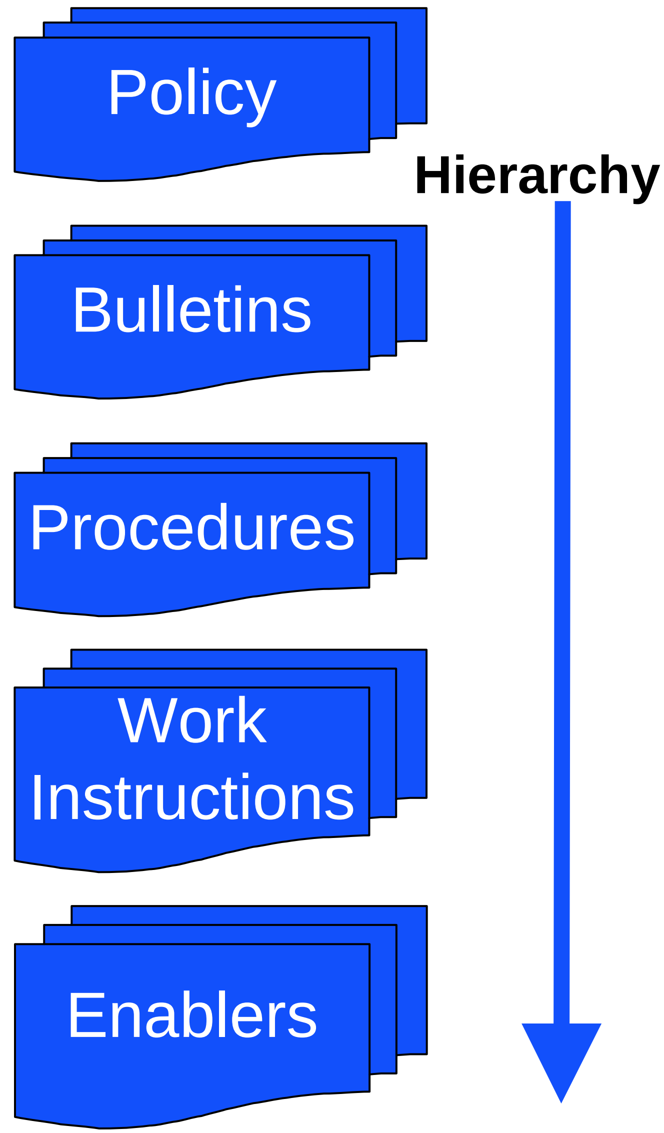
Raytheon Space and Airborne Systems

- **Membership**
  - **Key process leaders from each site**

- **Responsibilities**
  - **Provide the overall roadmap for the proposal**
  - **Identify complete list of existing processes**
  - **Develop initial recommended list of discipline-independent processes**
  - **Divide the process list into numerous mini-teams by topic**
  - **Determine common terminology to be used for the SAS Directives**
    - **Procedure versus Directive**
    - **Work Instruction versus Procedure**
  - **Secure resources to work mini-team reviews**
  - **Establish process for mini-teams to review processes**
  - **Review recommendations and estimates generated by the mini-teams**
  - **Roll-up estimates and present plan to management**

SAS Directive Structure

- **Policy:** **Directive and establishes the commitment that cannot be tailored.**
- **Bulletins:** **Used to augment policy for a short time or for frequently changing needs.**
- **Procedures:** **Directive and may not be tailored. Contain detail on “What to do”.**
- **Work Instructions:** **Directive and may be tailored. Contain detail on “How to do”.**
- **Enablers:** **Not directive. Enablers are provided to support implementation of Procedures and Work Instructions.**
  - **Enablers are samples, templates, checklists, etc. for what should be considered when performing a task.**



Mini-Teams

- Membership
  - Subject Matter Experts from each site for the various process areas
  - Multi-site representation was key to the success of the mini-teams
- Responsibilities
  - Meet (virtually) with the representatives from each site to review the existing processes
  - Develop a recommendation on the path forward for the specific process area
    - Keep one site's existing process as is
    - Merge existing processes from all sites
    - Eliminate the process
    - Elevate the process to be discipline-independent
  - Generate detailed Basis of Estimate (BOE) to document the effort required to accomplish the recommendation of the team

Example Mini-Team

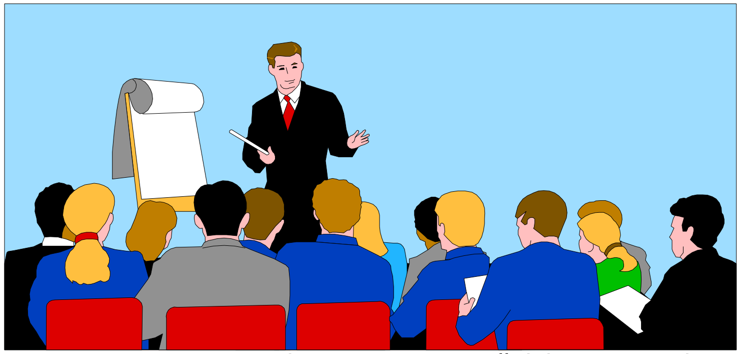
- **One mini-team was assigned the Peer Review Process**
  - **Subject Matter Experts on the existing processes were identified**
- **Current State**
  - **SE Peer Review Directive and Procedure in Texas**
  - **SW Peer Review PRG and Procedure in Texas**
  - **Separate SE and SW Peer Review Work Instructions in El Segundo**
  - **Five enablers in Texas and three enablers in El Segundo**
  - **HW did not yet have a Peer Review process at either site**
  - **Defect Logger Tool (Access database) used in Texas and Integrated Project Reporting Tool (Excel spreadsheet) used in El Segundo**
- **Recommendation**
  - **Form one discipline-independent Peer Review process**
    - **Common definition of a defect and common set of codes for defect classification (type, reason and priority)**
    - **Common program phases for defect containment**
    - **Create an alternative, less formal process for Desk Checks**
  - **Deploy the Defect Logger Tool to all geographic locations**

Management Review

Raytheon
Space and Airborne Systems

- **Membership**
  - **SAS President and VP of Engineering**
    - **Approve the budget for the plan**
  - **Functional line management**
    - **Approve the technical approach**

- **Responsibilities**
  - **Review and approve the plan presented by the Core Proposal Team**
  - **SAS President and VP of Engineering reviewed the budget and ability of the plan to meet the goal**
  - **Functional line management reviewed the recommendations of the mini-teams to ensure they were aligned with the recommendations**



SAS EMS ENTERPRISE SOLUTION

Proposed Changes

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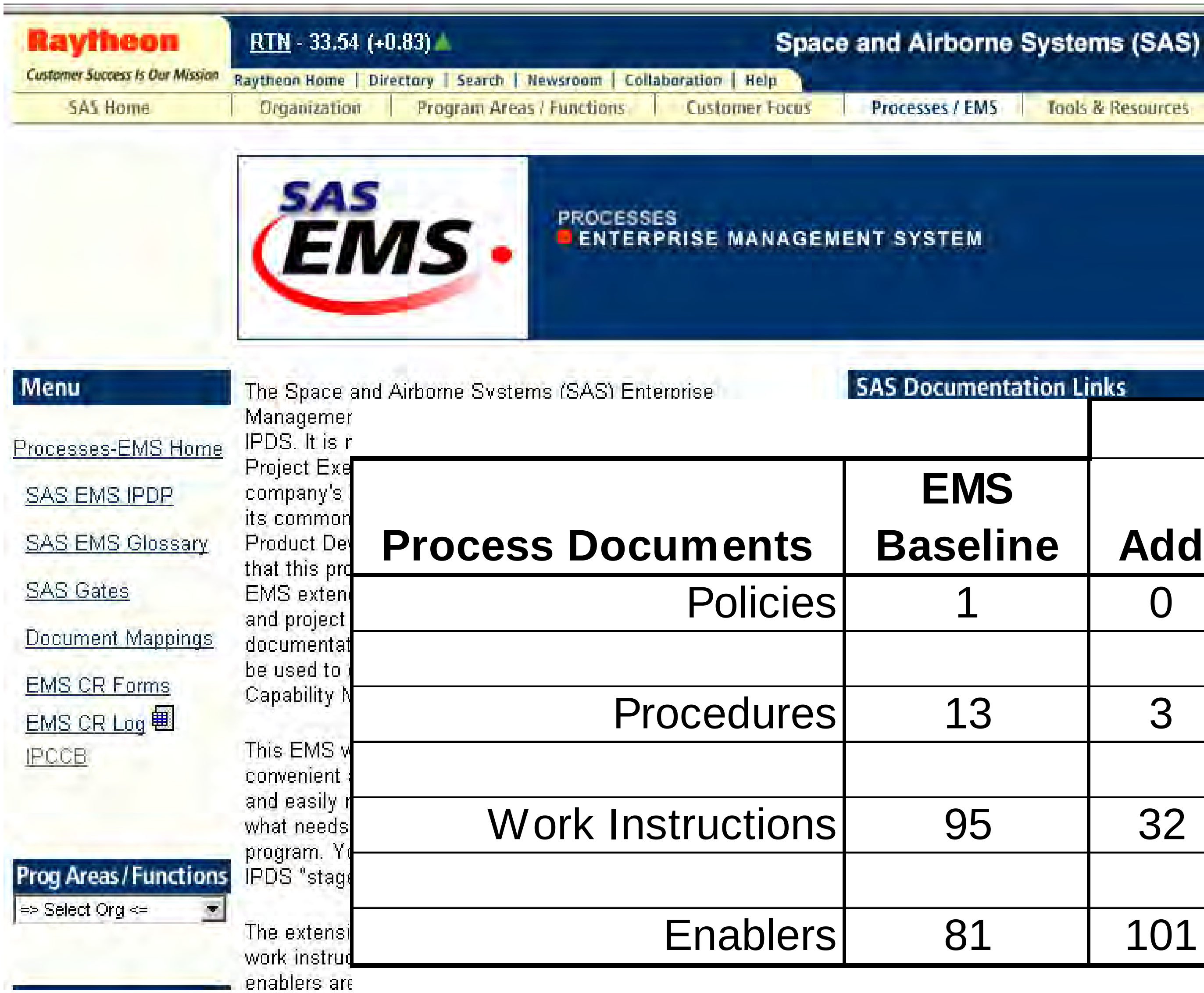


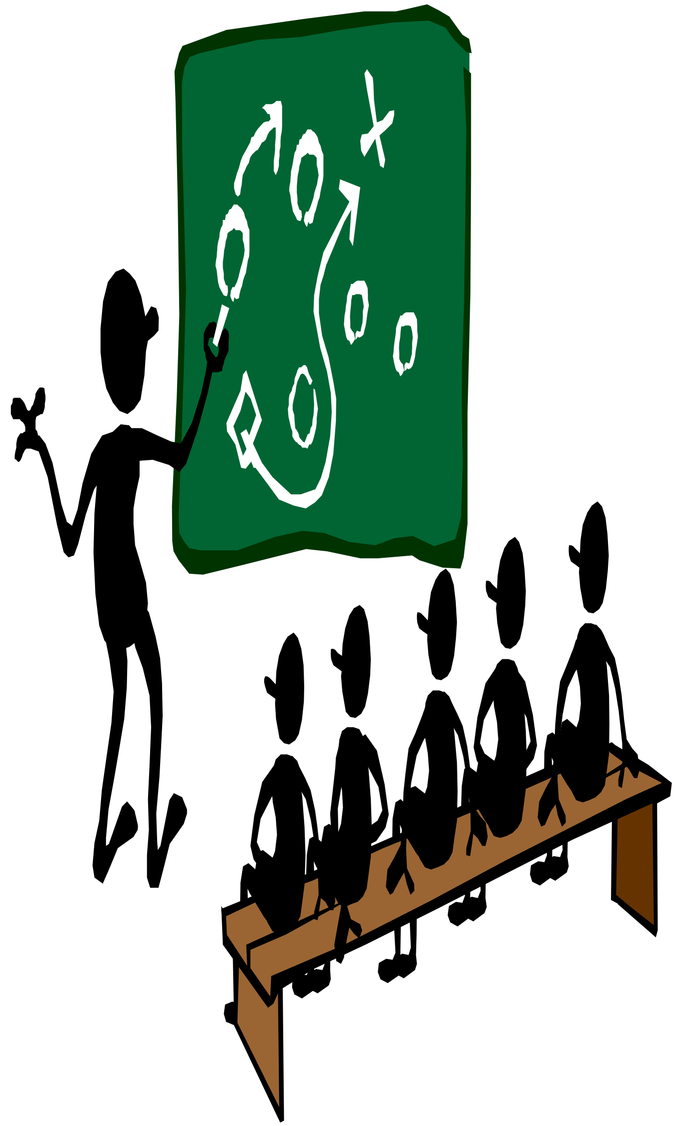
Process Documents	EMS Baseline	One SAS Add	Delete	Modify*
Policies	1	0	0	0
Procedures	13	3	0	26
Work Instructions	95	32	20	59
Enablers	81	101	9	39

* A document can be "modified" more than once eg. Driven by IPDP stage or discipline related

Discipline-Independent Processes

- **A key goal of our process merger effort was to replace discipline-specific processes with discipline-independent ones wherever possible**
  - **Discipline-independent processes are referred to as "common" processes**

- **Benefits include:**
  - **Reduces the number of processes to maintain**
  - **Facilitates common execution of process across all disciplines**
  - **Allows integrated teams to talk the same language**



Discipline-Independent Processes

Raytheon
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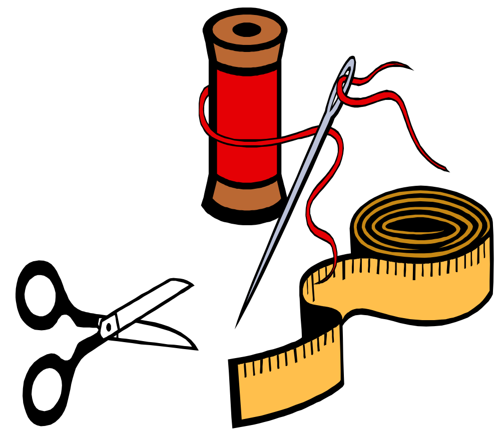
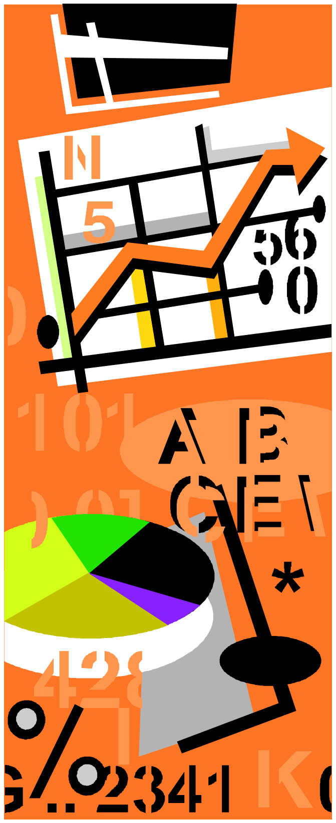
- **Process Tailoring**
  - Describes how programs will perform tailoring, including both discipline-independent and discipline-specific processes



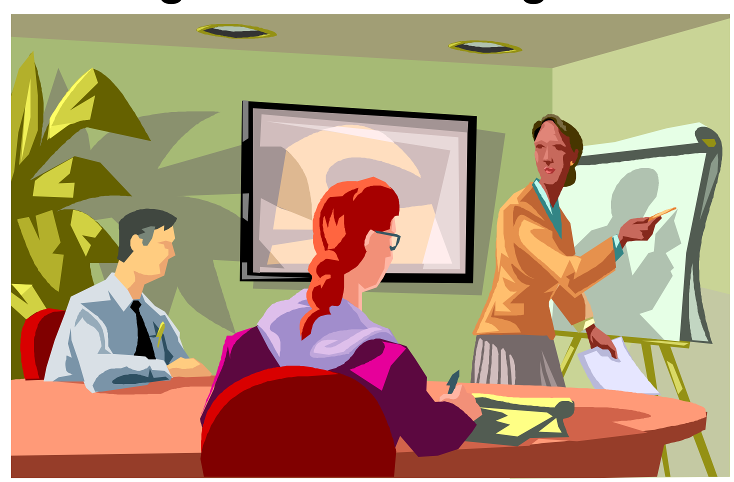
- **Program Planning**
  - Created a process, called the Program Management Plan, for the program-level planning elements
  - Kept discipline-specific processes for details of planning requirements by discipline
    - Systems Engineering Management Plan
    - Hardware Development Plan
    - Software Development Plan

- **Standardized on a 3-phase tailoring and planning approach for all disciplines**

Discipline-Independent Processes



- **Project Measurement & Analysis**
  - **Used to help the program establish their metrics plan**
- **Team of X**
  - **This is an interactive meeting between program personnel and line management to review program metrics, status, issues, processes**
- **Integrated Management Review**
  - **This is a periodic review with higher level management that can involve more than one discipline**



Discipline-Independent Processes

- **Structured Decision Making**
  - Process for making formal decisions that could have a significant impact to the program

- **Risk and Opportunity Management**
  - Describes how to identify, categorize and manage risks and opportunities for all disciplines
- **Work Product Management and Stakeholder Involvement**
  - One matrix that lists the program's work products, level of control for each, stakeholder involvement for each and designates which work products must be reviewed using the Peer Review process

- **Cost Estimation**
  - Originally thought to be disciple-specific, but later determined it could be discipline-independent
  - Still under development, but a new version to be piloted soon

Discipline-Independent Processes

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- **Project Teaming**
  - Describes the establishment of integrated product teams
- **Peer Review and Desk Check**
  - Peer Review process meets the requirements of the CMMI model
  - Desk Check process is a less formal process that can be used
- **Gate Reviews**
  - This is an independent review of the program at major phase transitions
- **Objective Evaluation**
  - Process and product audits by independent evaluators

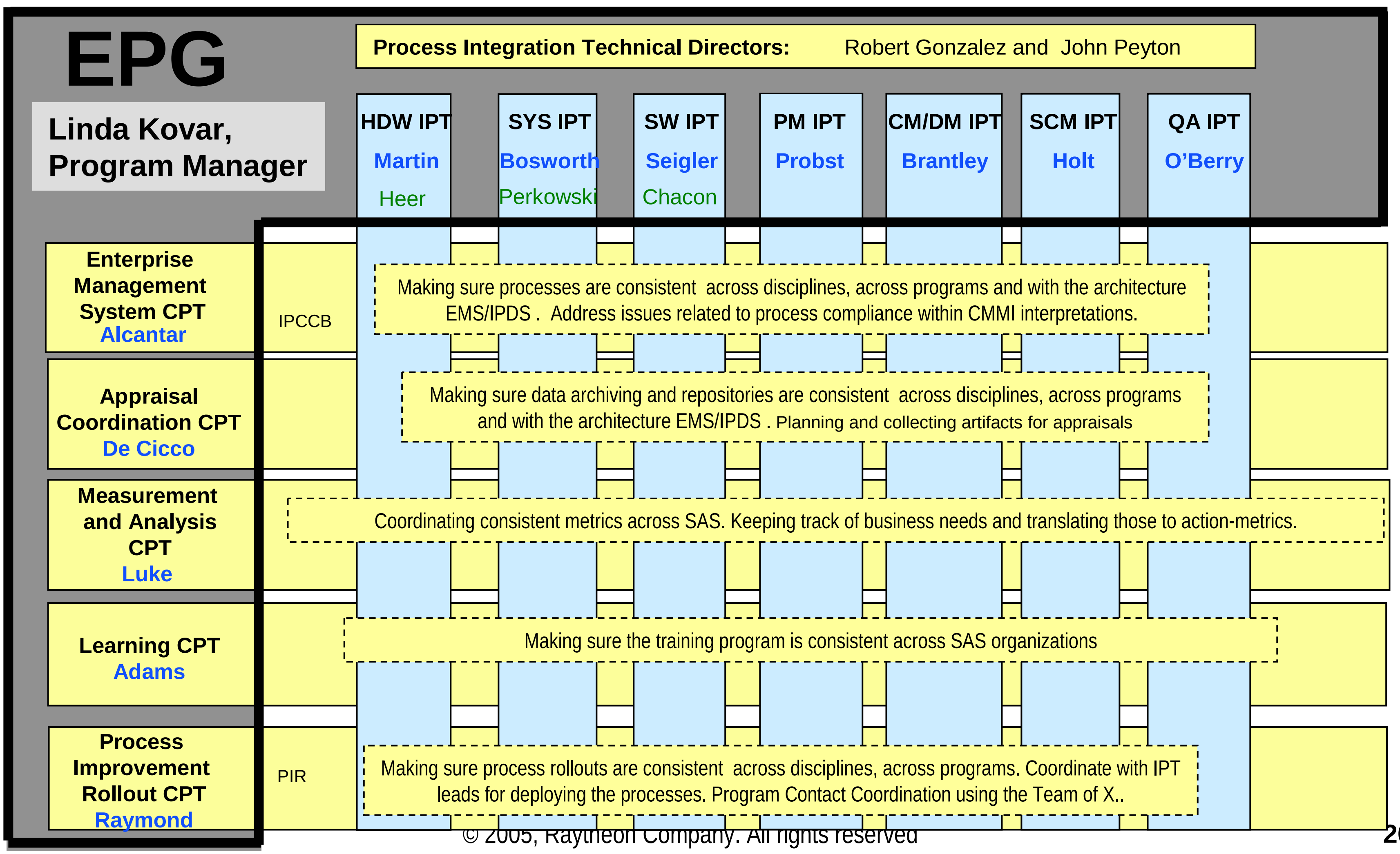
OneSAS EPG

Raytheon
Space and Airborne Systems

- **The plan of attack included unifying the various process groups across the business into a single Enterprise Process Group (EPG)**
  - **The new structure was referred to as the OneSAS EPG to make it obvious that we were unifying the process groups and the processes into one**
  - **Created a logo for the enterprise process integration effort**
- **The OneSAS EPG would include representation from all disciplines and sites and would be responsible for executing the process merger plan**
  - **A distributed team makes coordination and communication more difficult**
  - **The OneSAS EPG meets weekly via teleconference and Sametime**
  - **Meet face-to-face for all planning activities and once a month as a leadership team**

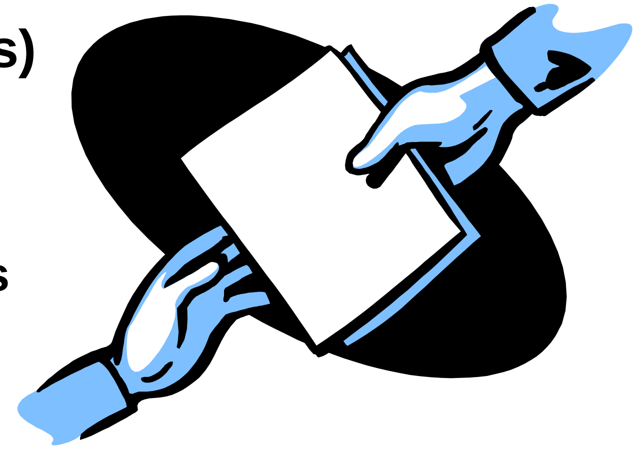
OneSAS EPG Organization

- **Implemented an Integrated Product Team (IPT) structure for process development and a Cross Product Team (CPT) structure for activities that cut across all IPTs.**



OneSAS EPG ConOps

- **Developed concept of operations (ConOps) for the IPTs and CPTs to define the interactions between them**
  - **One generic ConOps for the discipline IPTs**
  - **Five specific ConOps for each of the CPTs**

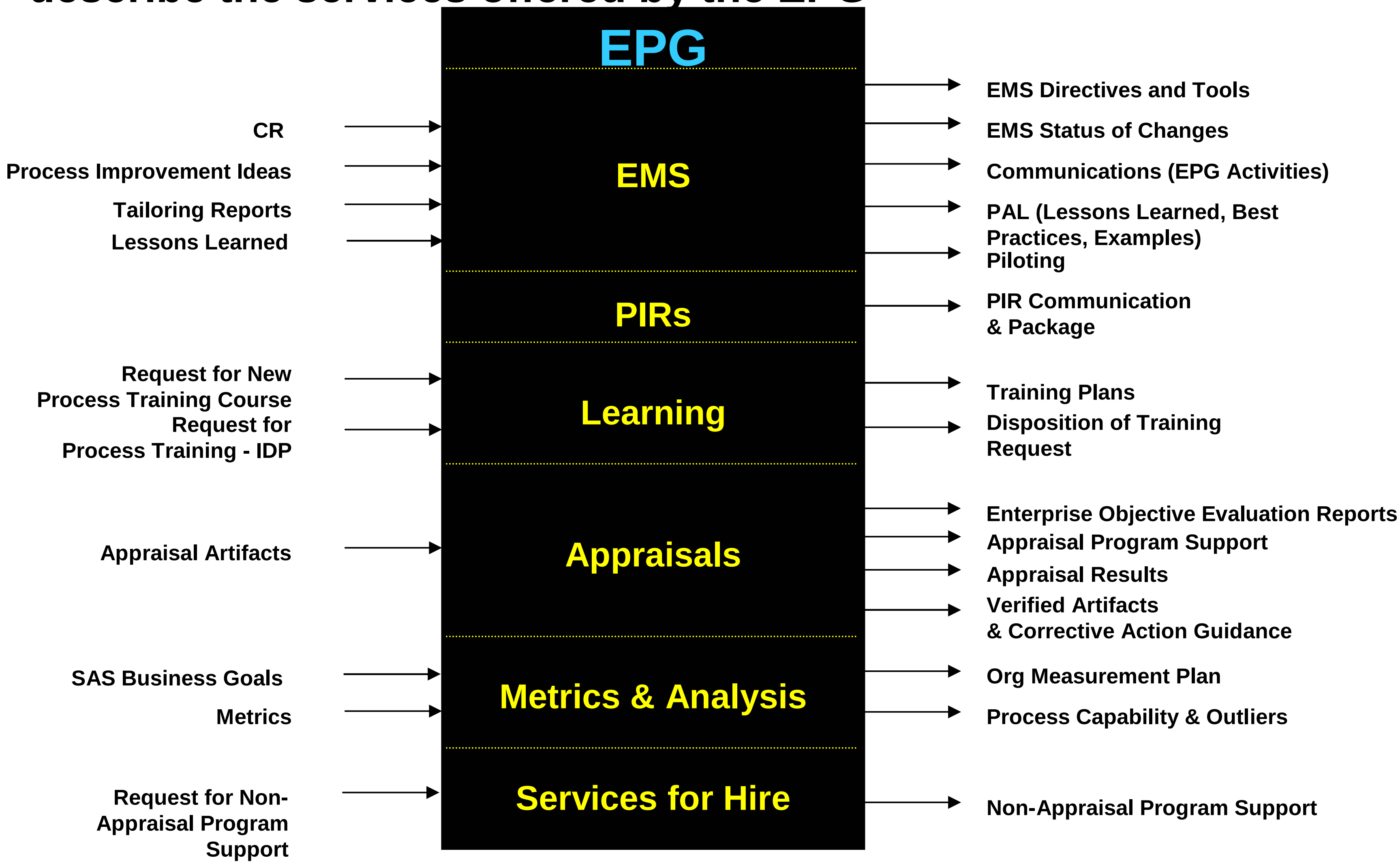


- **In addition, the following ConOps were needed for specific tasks**
  - **Top-level EPG**
  - **Process Definition**
  - **Process Support**
  - **Integrated Process Change Control Board Change Process**
  - **Enterprise Management System Website**
  - **Process Improvement Roll-out**
  - **Artifact/Data Collection**
  - **Artifact Gap Closure**

OneSAS EPG Services

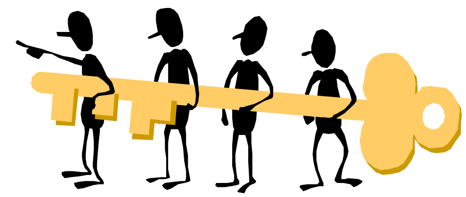
Raytheon
Space and Airborne Systems

- Created a chart showing the inputs and outputs from the EPG to describe the services offered by the EPG



Did it Work?

- The OneSAS EPG team was formed and worked very well together
  - Representation from each site and monthly face-to-face meetings were keys to our success



- All the discipline-independent processes discussed previously are released and are being used with the exception of Cost Estimation
  - Late decision to make Cost Estimation discipline-independent

- SAS Achieved CMMI Level 3 for Systems, Software and Hardware Engineering in August of 2005
  - This multi-site, multi-disciplined appraisal was the largest in scope for any business in Raytheon
  - It was the first CMMI appraisal to include Hardware

CMMI

Raytheon
Space and Airborne Systems

The Center for Systems Management completed a CMMI® based appraisal on August 30, 2005, in accordance with the Software Engineering Institute's SCAMPI℠, V1.1: Method Definition Document and it was determined that

Raytheon – Space and Airborne Systems

exhibited the characteristics of

SEI Level 3 Process Maturity
in Systems, Software and Hardware Engineering

as defined by the SEI CMMI® Version 1.1 SE/SW Staged Representation.

Albert J. Truesdale
SEI Authorized Lead Appraiser
The Center for Systems Management

CSM THE CENTER FOR SYSTEMS MANAGEMENT

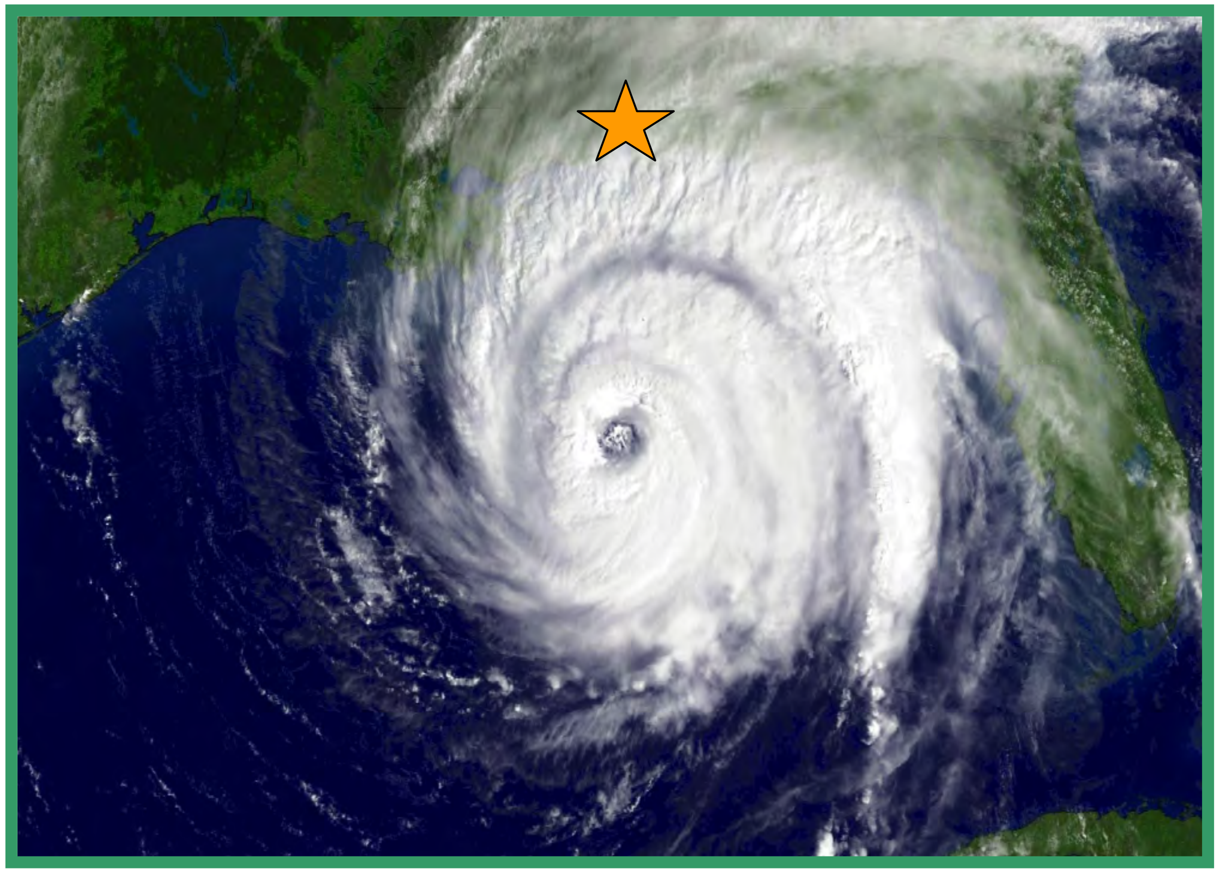
U. S. Air Force

Integrity - Service - Excellence

Looking for Transition in All the Wrong Places

96th Communications Group
Eglin Air Force Base, Florida
16 Nov 2005

Sunshine State



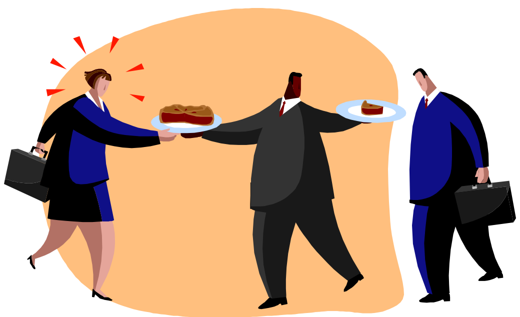
Outline

- Purpose
- Goal
- Scope
- Transition Process
- Results
- Lessons Learned
- Conclusion

Purpose

- **Communicate an effective method for transitioning new groups into an established Organization Software Process (OSP)**

- **Share process improvement experiences and lessons learned with other organizations**



Goal

- **Expand Process Improvement using an Effective Method by Leveraging from Established Processes**

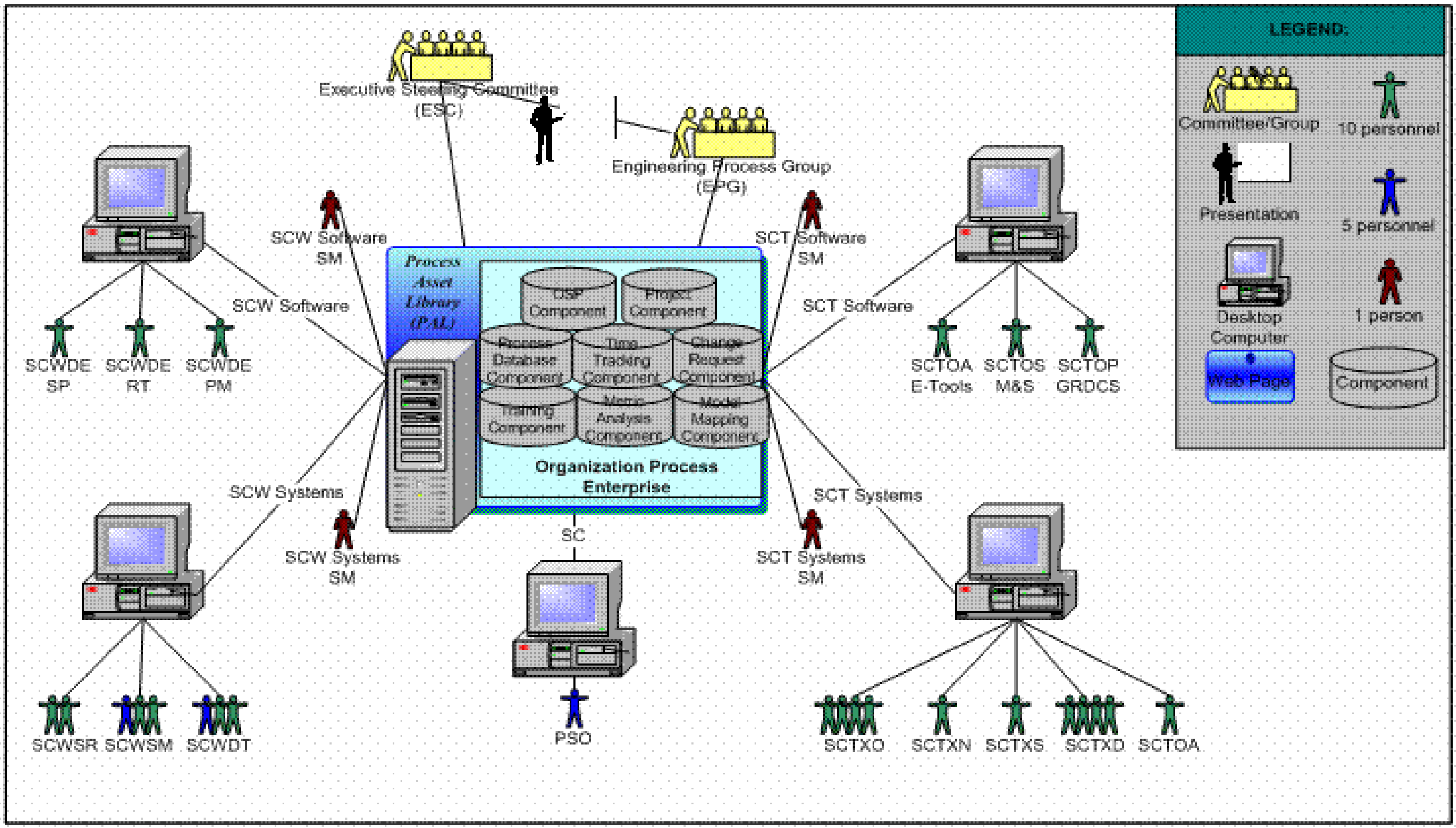
- **Identify Required Process and Tool Modifications to Support New Groups**

Goal (continued)

- **Apply Lessons Learned from Existing Software Groups**

- **Institutionalize Optimizing Processes into a New Group within 18 Months**

Organizational Scope



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Scope

- **Organization Achieved CMM® Level 5 with 6 Target Software Groups Defined**
  - **Primarily Software Development and/or Maintenance**

- **Transition New Software Group**
  - **50% Software Development and/or Maintenance**
  - **50% Systems Administration Support**

Scope (continued)

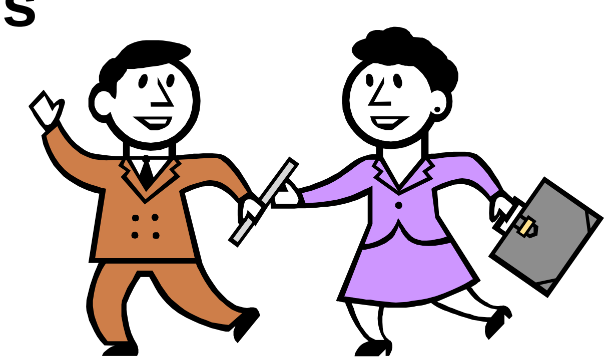
- **Transition 7 Systems Groups**
- **Migrate Software and Systems Groups to Software and Systems Capability Maturity Model Integration® (CMMI®)**
- **Transition Services Group based on Services CMMI®**

Transition Process

- Execute Orientation
- Establish Training Plan
- Identify Transition Activities
- Implement Transition
- Collect Measurements

Transition Process – Execute Orientation

- **Identify Support Infrastructure**
- **Identify Transition Team Members**
- **Update Documentation**
  - **Charters**
  - **Policies**
- **Communicate Transition Partner Activities**



Transition Process – Execute Orientation (cont)

- **Create a Transition Package**
- **Conduct Orientation Briefing**
- **Establish Meetings**
  - **Monthly Transition Status Meetings**
  - **Weekly Transition Working Meetings**

Transition Process – Establish Training Plan

- Coordinate Transition Partner Support Activities
  - Quarterly User Group Meetings
  - Monthly Senior Management Review Meetings
  - Weekly Technical Working Group Meetings
  - Weekly Software Engineering Process Group (SEPG) Meetings

- Execute Training Process to Create an Individual Training Matrix Form (ITMF) for Each Team Member

U.S. AIR FORCE

96th COMMUNICATIONS GROUP

Transition Process – Establish Training Plan (cont)

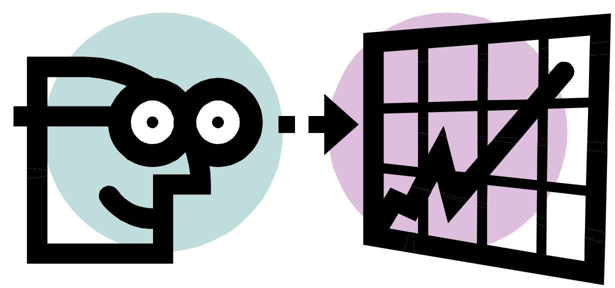
- **Create a Training Plan Based Upon Team Member Expertise**
- **Execute Training Plan Based on Defined Approach**
  - **Block Learning Approach - Requires the Student be Proactive in Learning and Applying the Training Skills**

  - **Spiral Learning Approach - Requires the Instructor be Proactive in Teaching Concepts that Build Upon Each Process and Applying Real-World Examples to Develop the Training Skills for Each Student**

Transition Process – Establish Training Plan (cont)

- **Update Individual Training Matrix Forms (ITMFs) Based Upon Completed Training Courses**

- **Distribute Updated ITMFs to the Organization Training Manager to Update the Training Database**

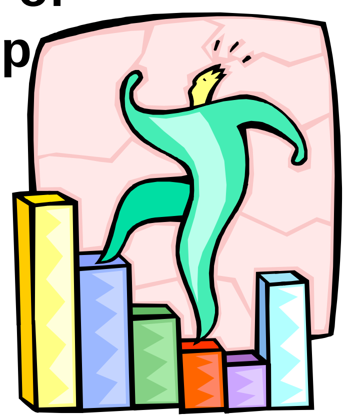


Transition Process – Identify Transition Activities

- **Document the Meeting Minutes**
- **Distribute the meeting minutes to Relevant Stakeholders to Communicate the Status**

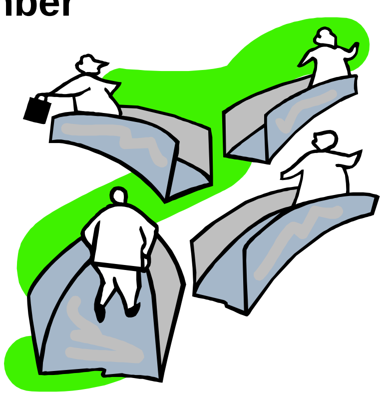
Transition Process – Identify Transition Activities (cont)

- **Review Each Process Step in the Organizational Software Process (OSP)**
  - **Identify which Process Steps are Executed in the Transition Group**
  - **Create Initial Metrics to Document the Number of Process Steps Currently Executed in the Group**



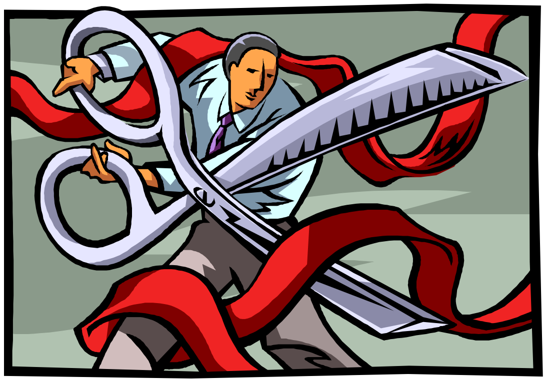
Transition Process – Identify Transition Activities (cont)

- **Assign Complexity to Each Step using (Role Factor x Process Factor)**
  - **Role Factor – Who Performs the Step**
    - **1 = Executive Steering Committee, Senior Management, SEPG, Organization Training Manager, Organization Software Quality Assurance (QA) Manager, or Project Support Office**
    - **2 = Project Quality Assurance Manager, Configuration Management Manager, First Level Supervisor, Group Leader, Configuration Control Board (CCB), Transition Partner**
    - **3 = CCB Member, Project Leader, Development Team Member**



Transition Process – Identify Transition Activities (cont)

- **Assign Complexity to Each Step (Role Factor x Process Factor)**
  - **Process Factor – Action Verb in the Step**
    - **1 = Acquire, Attend, Submit, Provide, Update, Add, Coordinate, Distribute, Place, Schedule, Notify, Initiate, Store, Approve, Reach Consensus, Assign, Send, Proceed, Collect, Annotate**
    - **2 = Record, Identify, Document, Consolidate**
    - **3 = Analyze, Verify, Execute, Convene, Determine, Define, Develop, Conduct, Discuss, Process, Perform, Complete, Examine**



Transition Process – Identify Transition Activities (cont)

- **Pre-defined Process Criticality in Transition Metrics**
  - **C = Consistency Failure if Step is not Executed**
  - **D = Data Collection Failure if Step is not Executed**
  - **P = Performance Failure if Step is not Executed**

Transition Process – Identify Transition Activities (cont)

- **Document and Prioritize Steps not Performed in the Group**
- **Document Effort, Duration, Software, Affected Personnel and Hardware Resources Based Upon Complexity Factor**

Transition Process – Identify Transition Activities (cont)

- **Conduct Transition Overview Briefing with the Team to**
  - **Review Organization's Process Improvement Journey**
  - **Train the Transition Process**
  - **Show the Way Ahead**

Transition Process – Implement Transition

- **Select a Project within the Transition Partner Group to Pilot the Organizational Software Process**
- **Identify a Project Mentor from an Existing Group**
- **Acquire Feedback for Process Updates Based Upon the Pilot Project**

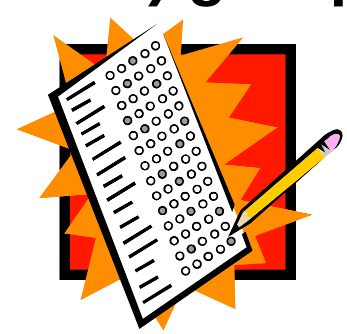
Transition Process – Implement Transition (cont)

- Submit Change Request for Feedback Requiring Organizational Software Process (OSP) Modifications to the SEPG
- Update the OSP to Support the Transition Partner
- Coordinate Training for the OSP Modifications

Transition Process – Implement Transition (cont)

- Provide Training Matrix Updates to the Organizational Training Manager to Update the Training Database

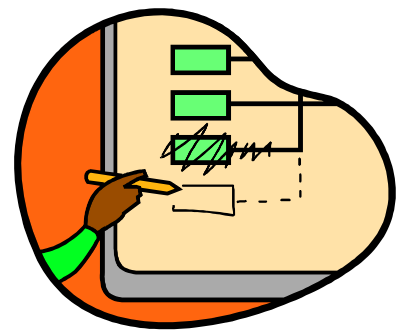
- Pilot the updated Organization Software Process (OSP) within an existing (experienced) group



Transition Process – Implement Transition (cont)

- **Acquire Feedback and Lessons Learned Based Upon the Pilot**

- **Submit the Organizational Software Process (OSP) Change Request to the SEPG as Applicable**



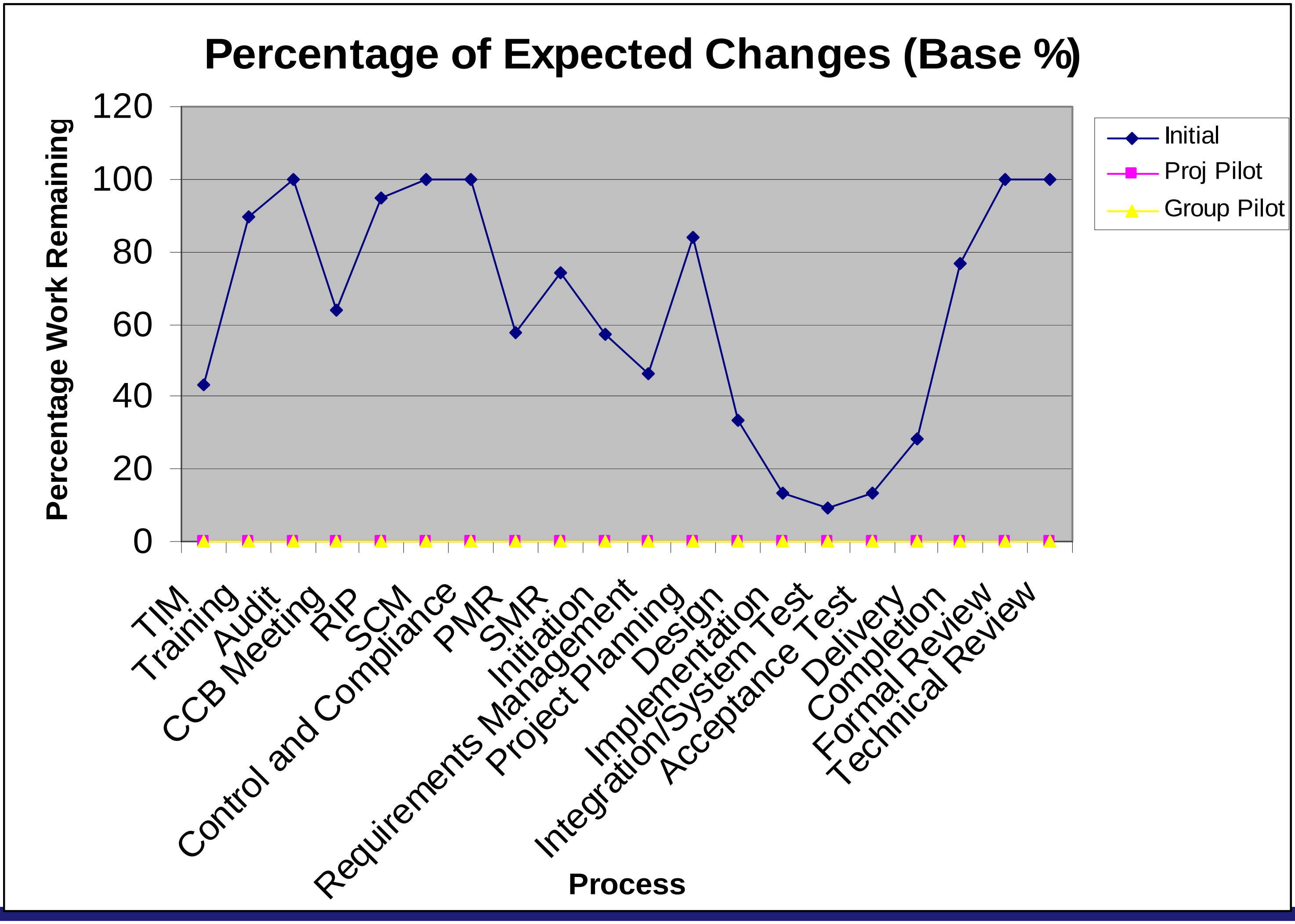
Transition Process – Collect Measurements

- **Document the Actual Effort (in hours) Expended to Complete the Transition Tasks**
- **Document the Estimated, Planned and Actual Changes to the OSP**

Results

- Allocated 10% - 20% Effort to SEPG Mentor assigned for Process Facilitation
- Showed Process Changes Expected during Initial Analysis; however, Showed No Process Changes Required from Piloting Feedback
- Established a New Target Software Group in less than 1 year, which indicates Transition Process is Extremely Successful

Results (continued)



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Results (continued)

Transition Process Complexity Analysis Form (TPCAF)

As of:	30 December 2004								
Process Name	**Step#**	**Yes/No**	**Base %**	**Criticality Factor**	**Role Factor**	**Process Factor**	**Step Complexity Factor**	**Process Complexity Factor**	**Work Remaining**
Technical Interchange Meeting (TIM)	1	Yes	43.48%	C			0	49	21.30
	2	No		D	3	2	6		
	3	Yes		D			0		
	4	Yes		C			0		
	5	No		C	3	1	3		
	6	No		D	1	1	1		
	7	Yes		C			0		
	8	Yes		C			0		
	9	Yes		C			0		
	10	No		C	3	2	6		
	11	No		C	3	2	6		
	12	No		P	3	2	6		
	13	No		P	3	2	6		
	14	Yes		C			0		
	15	Yes		P			0		
	16	No		P	3	2	6		
	17	Yes		D			0		
	18	Yes		C			0		
	19	Yes		C			0		
	20	Yes		D			0		
	21	No		C	3	1	3		
	22	No		D	3	2	6		
	23	Yes		D			0		

- **Criticality Factor**
  - **C – Consistency**
  - **D – Data Collection**
  - **P – Performance**
- **Role Factor (who)**
  - **1 – Management**
  - **2 – Support**
  - **3 – Team**
- **Process Factor (verbs)**
  - **1 – Simple**
  - **2 – Average**
  - **3 – Difficult**
- **Step Complexity**
  - **Role * Process Factors**
- **Process Complexity**
  - **Add up Step Complexities**
- **Work Remaining**
  - **Base % * Process Complexity Factor**

Lessons Learned

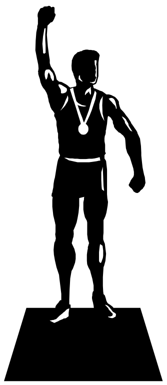
- **Tailor the Training Plan Based Upon Personnel Skills and Experience**

- **Demonstrate Tool Functionality using an Example Project During Training Sessions**

Lessons Learned (continued)

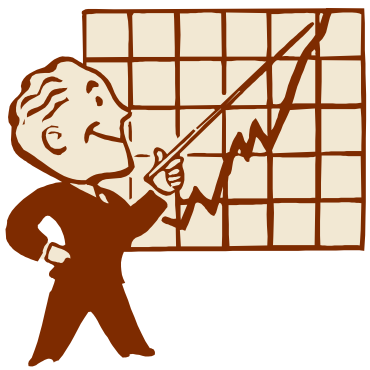
- **Communicate Activity Status and Schedule Changes on a Periodic Basis**

- **Identify a Process Champion to Regularly Mentor to Other Team Members**



Conclusion

- **Expected Transition to Require Updates to the Organizational Software Process and Associated Artifacts, but we were "Looking for Transition in all the Wrong Places" because**
  - **Basic Engineering Principles implemented within the Organization provided a means to Utilize Existing Processes**
  - **New Processes do not need to be created for each Discipline**
  - **Cultural Change versus Documentation/Process Change is a More Effective Means for Transitioning**



Conclusion (continued)

- Plan to Utilize the Transition Process to
  - Expand Process Improvement to Groups with Systems Engineering (SE), Supplier Sourcing (SS) and Integrated Process and Product Development (IPPD) Disciplines
  - Leverage Existing Processes to Reduce the Cycle Time for Developing Processes that Support the Software Engineering, Supplier Sourcing, and Integrated Process and Product Development

Questions?

Floridian Transition Process

Accelerating Process Improvement Through Collaboration

The NAVAIR Systems Process Improvement (SPI) Community of Practice (CoP)

Topics

Definition: What is a CoP?

"Communities of Practice are places of learning where we find out what others already know and can do, and where others find out what we already know and can do.

- A CoP has a subject which is of interest to people with different backgrounds and different perspectives.
- A CoP's prime importance is attached to practical experience and questions. The members exchange experiences and jointly search for answers to their questions and solutions to their problems.
- A CoP organizes itself: The members agree on the scope and demarcation of the subject, work, and forms of exchange and joint products.
- A CoP must be fun so that it is personally enriching." (2)

The boundaries of the CoP are defined by actual participation, not by affiliation or title. (6)

Definition: What is a CoP?

There are essentially two types of CoPs (4):

<u>Self Organizing</u> Self-organizing CoPs are also self governing. They pursue the interests of the groups members. Due to their voluntary nature, they are fragile yet resilient. They are fragile in that attempts to manage them can cause the members to disband or go “underground.” Yet they are resilient in that members come and go as interests shift and subjects evolve.

<u>Sponsored</u> Sponsored CoPs are initiated, chartered, and supported by management, and are expected to produce measurable results that benefit the organization.

The NAVAIR SPI CoP is a hybrid, simultaneously both self-organizing <u>and</u> sponsored. Sponsorship from the NSSC was critical to launch and initial momentum, but there is no hierarchy.

Rationale and Business Case for CoPs

There are compelling reasons and business cases for establishing communities of practice. Some rationale found by others for this undertaking are:

1. Information superiority provides the joint force a competitive advantage only when it is effectively translated into superior knowledge and decisions. (1)
2. Uncertainty from downsizing, retirements, etc. (1)
3. Reduce time in meetings, on email, on phone (1)
4. Need for greater organizational focus (1)
5. Reduce redundant efforts (1)
6. Need for faster, better informed decisions

Rationale and Business Case for CoPs

Compelling reasons and business cases for establishing communities of practice … continued:

7. Sustainable, competitive advantage (4)
8. Continuous innovation (4)
9. Reduce reinvention
10. Avoid repeating same or similar mistakes made by others
11. Accelerated process improvement and implementation
12. Institutionalize organizational and individual learning

Establishing a CoP Culture

Enablers and Inhibitors to Successful CoPs (1)

Enablers	Inhibitors
High trust	Fear and suspicion
Sharing is rewarded	Hoarding is rewarded
Team-based work	Individual effort
Process focus	Function focused
Open to outside ideas	Not invented here
Time to share	Too busy to share
Compatible IT	Incompatible IT
Need-to-share	Compartmentalization
Local decision-making	Central, top-down decisions

NAVAIR and SPI CoP Drivers

The NAVAIR software and systems community continuously evolves, and must find innovative solutions to the challenges of delivering quality systems to the Warfighter as effectively and efficiently as possible.

The times and environment demanded change:

- Multiple product teams in dozens of locations
- Supporting about 85 platforms and programs
- Seemingly disparate improvement initiatives from executive leadership
- Increasing demand to reduce the cost of software and systems while increasing quality and reducing cycle time

NAVAIR and SPI CoP Drivers (cont)

In other words, the NAVAIR software and systems organizations was in the same situation as many other organizations (maybe even yours).

One possible solution was to form a real Community. The formation of a NAVAIR Systems Process Improvement Community of Practice (SPI CoP) promised some ways to meet the challenges:

- Sharing process improvement best practices and process assets to avoid reinvention
- Continuously sharing lessons learned so they don't have to be re-learned
- Sharing resources to accomplish common goals and resolve common problems

The NAVAIR SPI CoP Vision

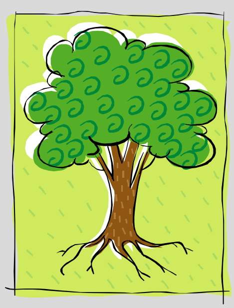
The SPI CoP is a forum for NAVAIR Software/Systems Process Improvement (SPI) teams to share processes, procedures, tools, and lessons learned to improve the timely production and delivery of quality software to the Warfighter.

NAVAIR SPI CoP Goals

To be considered successful, the NAVAIR SPI CoP should achieve these goals and deliver these benefits to the NAVAIR software and systems engineering community:

1. Establish a NAVAIR community of Process Improvement (PI) advocates from across teams and competencies responsible for providing software-intensive systems to the warfighter.
2. Provide a forum for sharing software / systems engineering and management products such as processes, procedures, lessons learned, tools, and code.
3. Create / use a repository of process improvement products.
4. Communicate insights and products shared by this forum back to the teams and competencies, and where appropriate, advocate their effective use on programs.
5. Provide a collective voice for capturing and evaluating systemic software/systems process improvement issues and needs.

Brief History of the NAVAIR SPI CoP



Oct 04	Research conducted to understand communities of practice; began planning charter meeting
Nov 04	First meeting in San Diego: initial community representation established; no professional facilitation; prototype agenda;
Jan 05	e-Room in early stages of design and prototyping
Feb 05	Second meeting in New Orleans: Standard meeting items piloted; e-Room structure unveiled; first working groups formed; externally facilitated; meeting evaluations introduced
May 05	Third meeting in Annapolis; Agenda working group formed; training day added as standard feature to meeting agenda; externally facilitated; WGs report progress/status
Sep 05	Fourth meeting in Las Vegas: highest attendance to date; self-facilitated; Yellow-Belt training; Mission Area Teams leverage meeting

SPI CoP Successes

The NAVAIR SPI CoP has resulted in these successes and benefits:

- Gives boost to the formation of a consolidated SSEPGs (Strike MAT and Special Mission MAT)
- Has saved member communities significant effort by preventing reinvention and rework of process assets
- Is engendering a common language for process improvement among member organizations
- Puts members in touch with expertise and experience they were previously not aware of
- Enables community members to address systemic, community-wide problems … no one has to “go it alone”
- Has dramatically increased the availability of process assets for all members

Features of a NAVAIR SPI CoP Meeting

Training Day

SPI CoP meeting double functions as training by adding process-related training day to two-day SPI CoP meeting. Reduces NAVAIR-wide training costs through consolidation.

Affirmations

Community members provide testimonials of benefits to home organizations' PI efforts resulting from SPI CoP participation.

Environmental Scan

NAVAIR management has opportunity to address and discuss changes and initiatives that may affect all Community members.

Souvenir Sessions

Community members present or demonstrate processes or process assets that have worked in their home organizations.

Working Group Sessions and Out-briefs

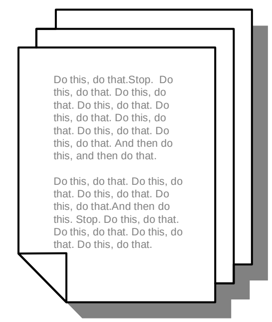
Working Groups have opportunity for face-to-face processing of goals and action items. Report progress and status to Community in same meeting.

Success Attributes of the NAVAIR SPI CoP

There are essentially 3 major components of the NAVAIR SPI CoP:

+

+



People

The participation of people with subject matter expertise who are willing to share their knowledge with others.

Technology

Shared information technology that provides media for the exchange of ideas and knowledge assets.

Processes

Methods and processes that enable the exchange of ideas and knowledge, and maintain the integrity of knowledge assets.

Major Attributes of SPI CoP Success
(continued)

People **are the most important component of the NAVAIR SPI CoP. It took people to form the SPI CoP, and it is for people that the Community thrives.**

Some of the attributes and qualities the people in the NAVAIR SPI CoP:

- Have knowledge, experience, and expertise in software/systems process improvement
- Members are representative of NAVAIR Product Teams, and are empowered to make process improvement commitments and decisions for home organizations
- Have a positive attitude toward sharing their expertise with others
- Make the time to participate in the SPI CoP

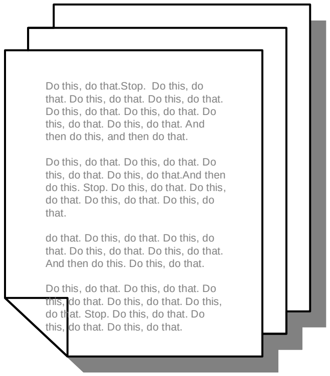
Major Attributes of SPI CoP Success
(continued)

Technology **has been critical to the success of the NAVAIR SPI CoP. The appropriate use of technology enhances the experience of the participants.**

Communication and work product sharing has been significantly enhanced through the use of an e-Room (Documentum). The major enablers are:

- Discussion threads
- Organized process asset sharing
- Easy, user-friendly document search based on standard attributes
- Simple access control
- Automated change and configuration management
- Automated e-Room usage and performance measures (community activity)
- Intuitive, user-defined database facility

Major Attributes of SPI CoP Success
(continued)



Processes **have been important but not critical to a successful SPI CoP. Well designed and executed processes ensures the SPI CoP thrives even when members come and go from the community.**

The critical few processes that have contributed to the NAVAIR SPI CoP success are:

- Decision making processes conducive to progress and inclusion (DAR)
- Agenda development and meeting minutes/action reporting processes
- Meeting logistics process
- Processes governing e-Room use
- Defined measures to collect and analyze to determine SPI CoP goal achievement

Institutionalizing the NAVAIR SPI CoP

Building the SPI CoP is one thing, making sure it thrives, endures, and continues to deliver value to the community is another. We are still working to ensure the SPI CoP addresses these important institutionalization factors:

- Collecting and reporting measures and other information that indicate benefits to member organizations
- Rewarding SPI CoP participation and contributions
- Developing and applying consensus definitions for concepts such as “good ideas” and “best practices”
- Monitoring community participation, and using experiential information and feedback from participants to continually enhance the experience
- Ensuring the media/technology used to support the SPI CoP is cost-effective, easy to use, and is driven by the needs of people (not the other way around)

We're still on the journey.

What We Have Learned

In just one short year, we have learned much about ourselves and our Community. Our advice to others thinking about forming a CoP includes:

1. Don’t re-learn our lessons.
2. Get members of the community involved as soon as possible in developing the meeting agendas; reward contributions.
3. Establish goals, and continuously review them and measure performance.
4. Use outside experts who have CoP experience to give launch power to start-up structuring and planning. But have weaning plan.
5. Use professional facilitation for meetings, but only up until the Community learns to self-facilitate. Make sure facilitators know content of Community’s interests and work.

What We Have Learned (continued)

If you're planning to form a CoP (continued):

6. Provide incentives for participation until participation becomes the incentive … "prime the pump."
7. Do not mandate participation.
8. Use technology to enhance communication, learning, and knowledge capture.
9. Find ways to make progress outside of meetings.
10. Make sure every event involves tangible take-aways.
11. Be very flexible. Follow the interests of the Community, even if it leads the Community to morph into something different.
12. Do not form a hierarchy; try to keep the community a network.
13. Don't put too much content into any one meeting; people need more time to focus and address each topic.

What We Have Learned (continued)

If you're planning to form a CoP (continued):

14. Provide multiple vehicles and avenues for feedback from the community members, and make it obvious that feedback is used.
15. SPI CoP can be a very effective forum for integrating multiple, unintegrated improvement initiatives.
16. Provide initial seed funding for meetings and travel, particularly when community members come from many different organizations.

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For More Information …

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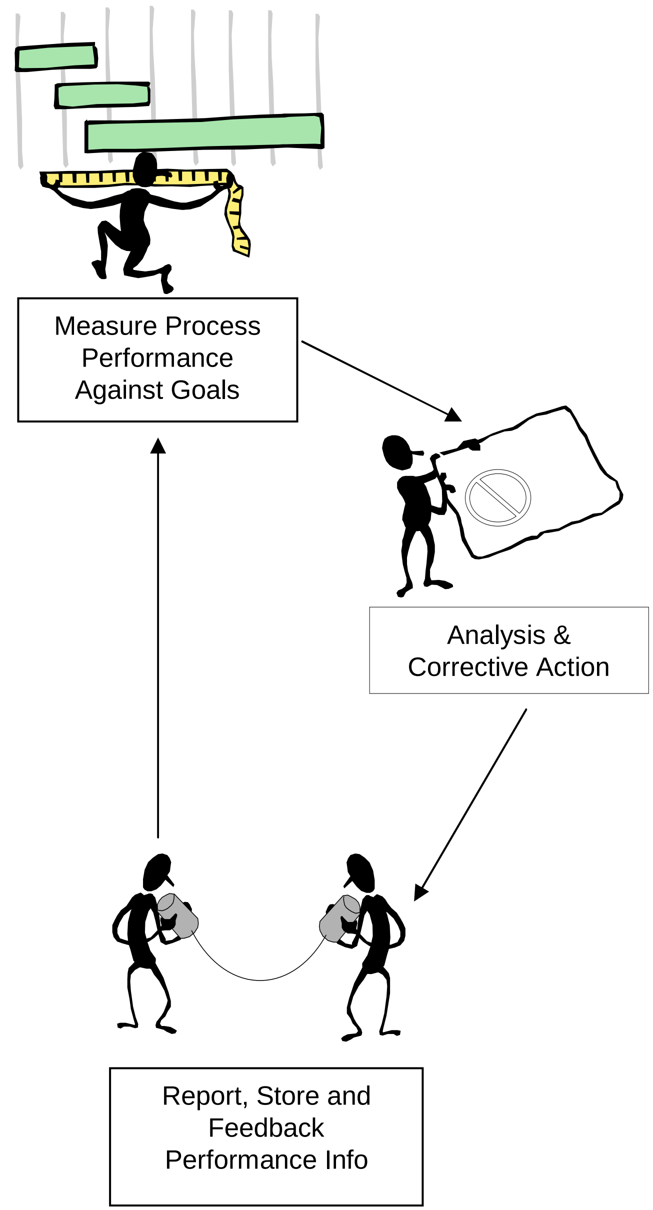
CMMI GP 2.8 Interpretation and Implementation: Is The Practice Just About Numbers?

5th Annual CMMI Technology Conference & User Group 14-17 November 2005

Gary F. Norausky
&
Les Stamnas

Agenda

- Review
- Three Keys
- Evolutionary Understanding
- Balancing Variables
- Measures For Success
- Implementation Pitfalls
- Appraisal Considerations



GP 2.8 Monitor and Control the Process

- Monitor and control the process against the plan for performing the process and take appropriate corrective action.
  - ✓ Perform the direct day-to-day monitoring and controlling of the process
  - ✓ Visibility into the process is maintained so that appropriate corrective action can be taken when necessary.
  - ✓ Measure appropriate attributes of the process or work products produced by the process.
- Refer to the Project Monitoring and Control process area for more information about (the topics of) monitoring and controlling the project and taking corrective action
- Refer to the Measurement and Analysis process area for more information about (using) measurement (as the reporting mechanisms in preparation for higher maturity level)

Involves Three Keys

Monitoring

Defined as:

The collection, recording, tracking and reporting of important activity information

Example Activities:

- Progress & status reporting of activities and products
- Updates to lists of action items, risks, problems, and issues
- Comparisons of actual process data against established goals, the cost / benefit analysis used when establishing a process

To watch, keep track of, or check for a special purpose

Measurement & Analysis

Defined as:

The development and sustainment of a quantitative capability to support sub-process or process (later for project and organizational needs)

Example Activities:

- Specifying goals and measures to collect
- Analysis mechanisms, baselines and decision thresholds
- Comparisons against goals and objectives
- Data storage and retrieval mechanisms (data management)

Using numbers to determine goal satisfaction (limits)

Control

Defined as:

Managing changes and corrective actions necessary to bring actual performance into agreement with plan

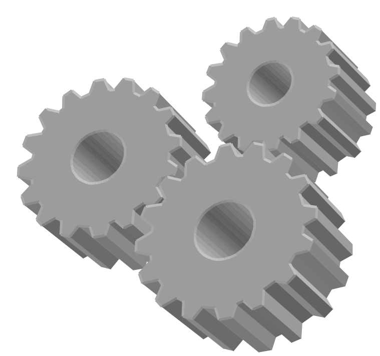
Example Activities:

- Updates to the plan and schedule, to reflect actual progress
- Resolution of items that were unknown or that have changed since the implementation / modification of a process

To exercise restraint or direct influence over: i.e., replanning

In An Evolutionary Manner, It Helps:

- Develop the rudimentary mechanisms to:
  - ✓ Identify what to collect to meet needs
  - ✓ Developing the capability to collect the right data and document and share best practices for a process area or sub-process
- Begin to establish the patterns for modeling and analysis for a collection of similar capabilities for a project
- Set the stage for understanding of the current strengths and weaknesses of the organization's processes and process assets
- Continue to support data needs for the advanced capability to achieve quantitative project and organizational objectives for quality and process performance through
  - ✓ Common measures
  - ✓ Process performance baselines
  - ✓ Process performance models



Additionally, It Is About

- Balancing these variables:
  - ✓ Needs – urgent want or necessity arising from circumstances
  - ✓ Verification – is it (or isn't it) satisfying process requirements based on needs
  - ✓ Change – do we or don't we change the process based on outcomes and variations compared against needs

"Process will always affect Project Performance!"
P. Lewis, Project Planning, Scheduling and Control

What Balance Translates Into

- Improving process performance together with management of the project
- Revealing problems early so that action can be taken
- Ensuring the quality of project work (e.g. process useage) does not take a back seat to schedule and cost concerns
- Verifying that in-place processes are used correctly (via expected outputs)
- Identifying areas where other project / process segments should be managed differently (what we did doesn't fit)
- Keeping clients / stakeholders informed of process / product / project status
- Reaffirming the organizations commitment to the project (continuous alignment with goals and objectives) [for the benefit of the team and stakeholders]

Ensuing that the established process is retained during times of stress

Process Data Collecting

- Data collected and reported should fall into these categories:
  - ✓ Frequency counts per time period - e.g. defects per thousand
  - ✓ Raw numbers in ratio – actual amounts used / produced against a limit
  - ✓ Subjective numeric ratings – ordinal rating of performance but can't be mathematically processed
  - ✓ Inferential – using indicators as surrogates for direct measures
  - ✓ Verbal characterizations – e.g. team work, stakeholder coordination
  - ✓ Qualitative – cultural characterizations about the process experience from implementers / users

Example PPQA
Evolutionary Measures For Maturity Level Success

- QA milestone completions compared to plan
- Work completed, effort expended compared to plan
- Number of product audits and activities reviews compared to plan
- Number of process audits and activities vs. those planned
- Amount of time / effort spent on rework
- Amount of time / effort spent in each phase of life cycle
- Number of defects per release, build
- Total number of defects found by internal reviews and verification activities vs those found by customer after delivery
- Number of defects injected in each phase of the life cycle
- Number of noncompliance's / nonconformance's written vs. resolved vs. escalated

2 Variance of objective process evaluations planned and performed

2 Variance of objective work product evaluations planned and performed

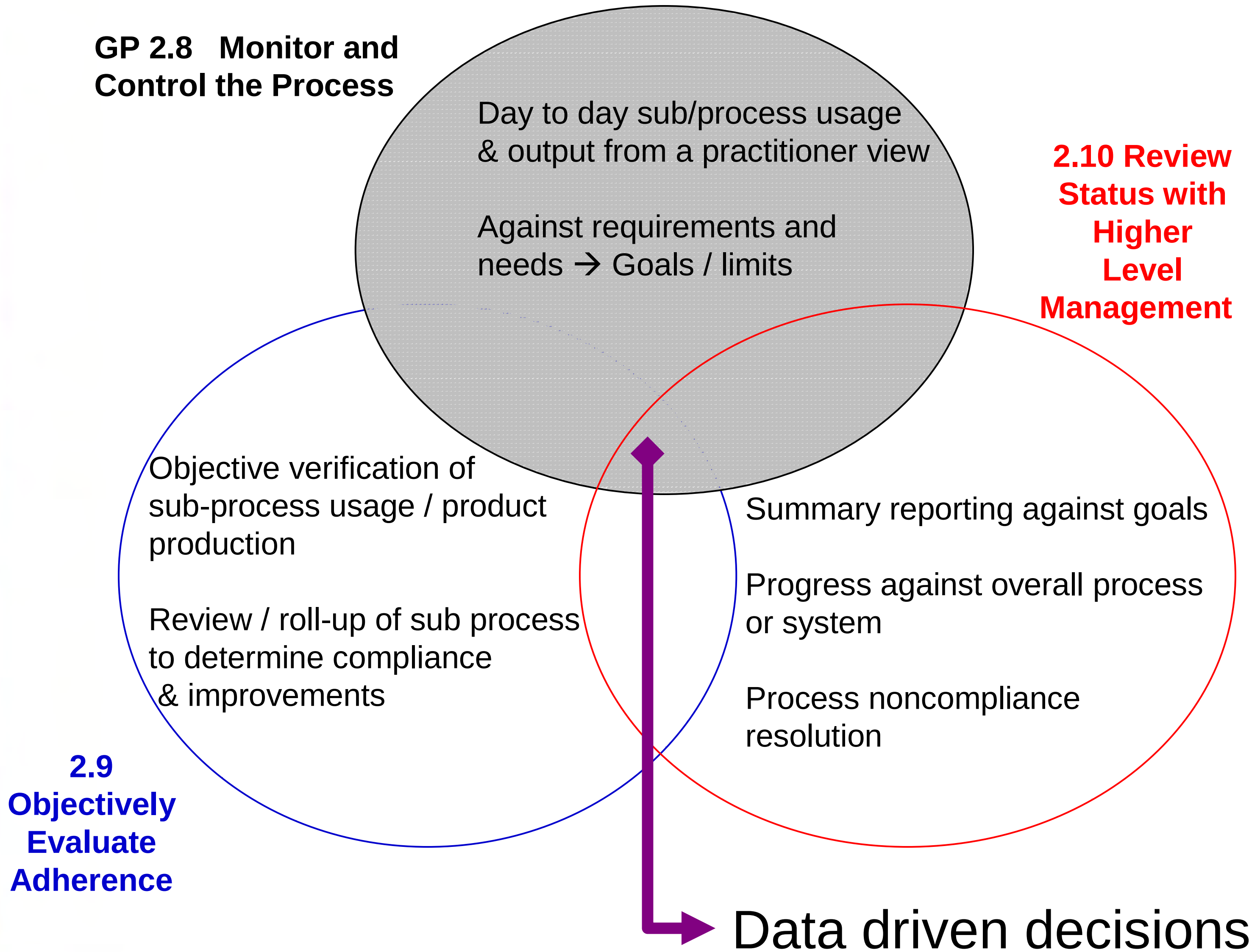
3 Number of process-improvement proposals submitted, accepted, or implemented

3 Defect density of each process element of the organization's set of standard processes

4 Profile of subprocesses under statistical management (e.g., number planned to be under statistical management, number currently being statistically managed, and number that are statistically stable)

4 Number of special causes of variation identified

Generic Implementation Interactions



It is all about data. And much more…

Misunderstandings

- Any process measurement will fill the void
- Doesn't include qualitative expressions of process monitoring and control
- Really only use data at CL / ML 3 and above
- Information doesn't always translate into dollars or ROI
- Is not proactive
- It doesn't include mistake prevention or proofing
- Emphasizing short run results at the expense of long-run objectives (myopia)

Understandings

- Start with the end in mind – what do you NEED
- Data comes from actual activity or sub-process use rather than generated CMMI model examples
- Often use qualitative information from "water cooler" to set context for numbers
- Set the initial mechanisms in place for eventually determining whether a process is in control or out of control (quality control, rework, etc)
- It is about learning error prevention vs. just correction

Implementation Pitfalls

- Jumping right into CL/ML 2 without understanding the processes or relationships among them (process areas over business processes)
- Too many/few measures - what isn't counted doesn't count
- Monitoring activity vice results
- Confusion over monitoring process inputs, rather than outputs
- Data easily gathered rather than those important for control
- Gold-platting
  - ✓ Using Earned Value on every small / very short during projects
  - ✓ Using production measures on documents
  - ✓ Demanding detailed completion data and confusing it with reality
- Difficult infrastructure for reporting
- Misalignment with organizational scorecards (e.g. Balanced ScoreCard, metrics dashboards, etc.)
- Not a closed loop system – collecting but not using

Appraisal Considerations

- Stacking deck to misrepresent or camouflage dysfunctional process, project or organizational activities
- Generic practice 2.8 implementation across all PAs (CL/ML L2→L5)
  - ✓ Can you show collection, usage, alignment, limits
- Direct Artifact Example:
  - ✓ Records of evaluations or audits being performed as planned (e.g., reports, completed checklists).
  - ✓ Noncompliance issues resulting from objective evaluation of adherence to processes, objectives, and standards.
- Indirect Artifact Example:
  - ✓ Revisions and change history to plans and commitments (e.g., replanned schedule, costs, resources).
  - ✓ Effort spent on the Process Area (e.g., reviews and action items regarding activities and Process Area)
  - ✓ Evidence of reviews of activities, status, and results of the process held with immediate level of management responsible for the process and identification of issues; (e.g. briefings, reports, presentations, milestones).
  - ✓ Issues and corrective actions for deviations from plan for executing the activities or Process Area (e.g., action items, variance reports, change requests).

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Measuring and Estimating Process Performance

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14-17 November 2005

Presented at the 5th Annual CMMI
Technology Conference & Users Group Meeting
Denver, Colorado

Topics

- **Defining and Controlling Production Processes**
- **Measuring Process Performance**
- **Predicting Process Performance**
- **References**

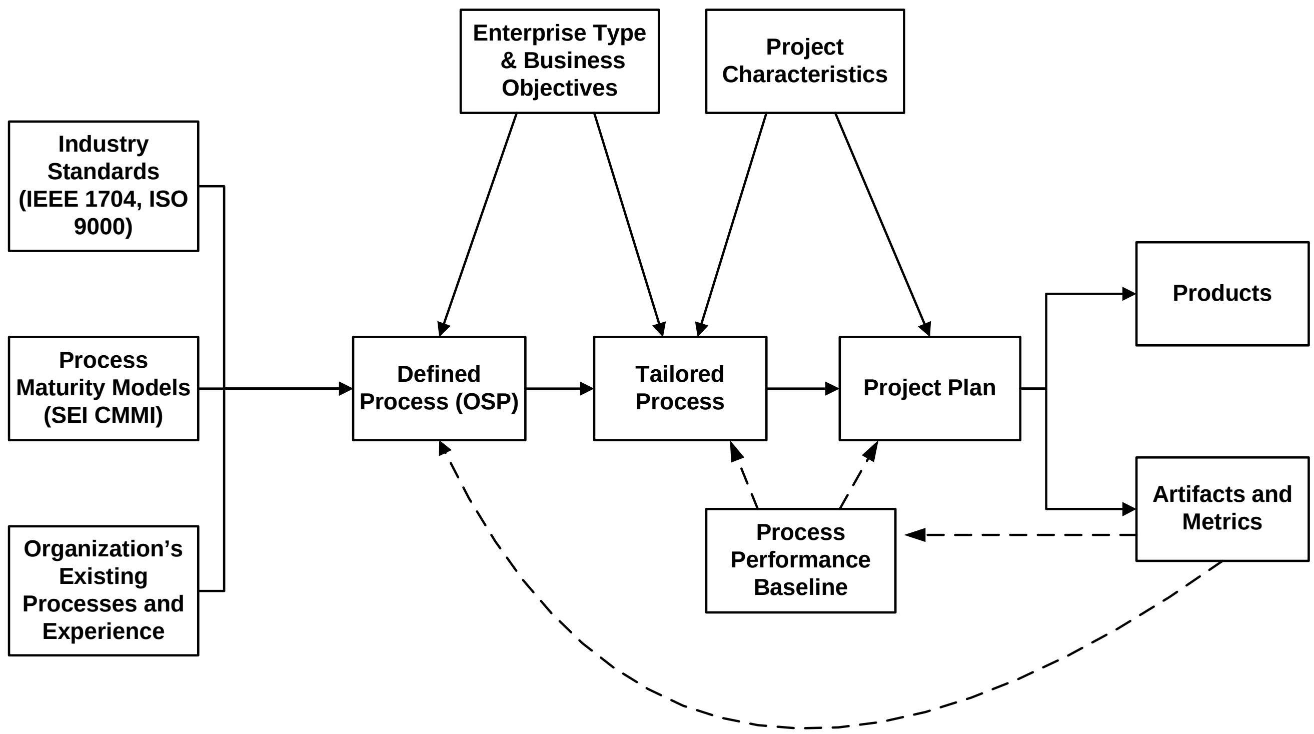
Definition of Process

A set of activities, methods, practices, and tools that people use to develop and maintain a product and its associated work products (e.g., plans, design documents, code, test cases, and user manuals).

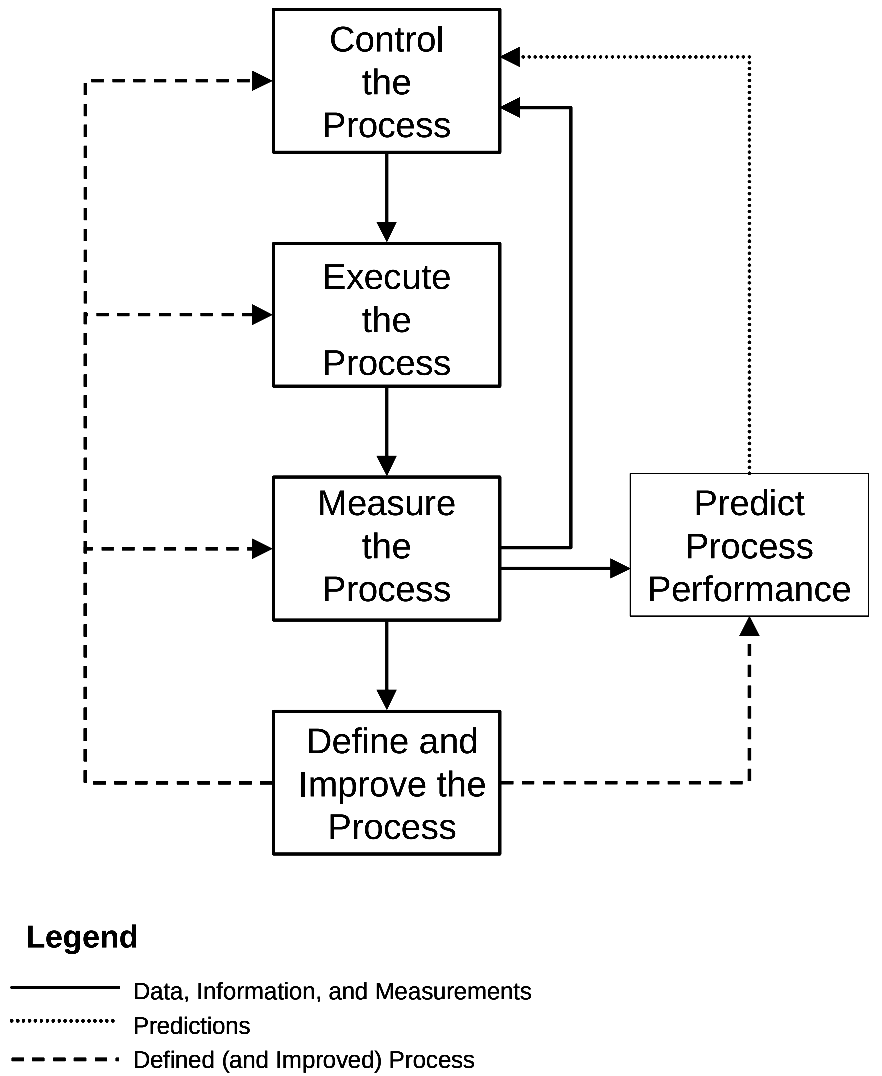
Types of Process Models

- **Capability Maturity Model**
  - **Best Practices**
  - **“Ought to”**
- **Process Architecture**
  - **Project life cycle model**
  - **Activities, artifacts, and timing**
  - **High-level “How to”**
  - **Basis for early planning**
- **Defined Process**
  - **Organization’s Standard Process (OSP)**
  - **Detailed “How to” plus aids (template tools)**
- **Project’s Tailored Process**
  - **Selected subset of the OSP**
  - **Some elements may be tailored**
  - **Basis for detailed planning (budget, status) and improvement**

From Best Practices to Products



Process Control: Measurements + Models



Measuring Process Performance

- **Key Questions**
  - **What is the current performance?**
  - **Is this value "good"?**
  - **Is it changing?**
  - **How can I make the value “better”?**
- **Candidate Attributes***
  - **Definition (completeness, compatibility)**
  - **Usage (compliance, consistency)**
  - **Stability (repeatability, variability)**
  - **Effectiveness (capability)**
  - **Efficiency (productivity, affordability)**
  - **Predictive Ability (accuracy, effects of tailoring and improvements)**

*Motivated by [Florac, 1999, Section 2.4]

Some Examples

Goal	Measure
Completeness	The number of process elements added, changed, and deleted during tailoring.
Compliance	Number of discrepancy reports generated by Quality Assurance audits
Stability (volatility)	The number of process elements changed within a specified time interval.
Effectiveness	Product quality
Effectiveness	Defect leakage to subsequent phases
Efficiency	Productivity (or production coefficient)
Efficiency	Rework as a fraction of total effort
Predictability	Probability distribution for an estimated quantity or related population statistics

Choosing Your Measures

- **Measurement costs money**
  - **Choose what is useful (e.g., use Goal – Question – Measure)**
  - **Your needs will change over time**
- **Factors to consider:**
  - **Business objectives**
  - **Customer desires**
  - **Government regulations and statutes**

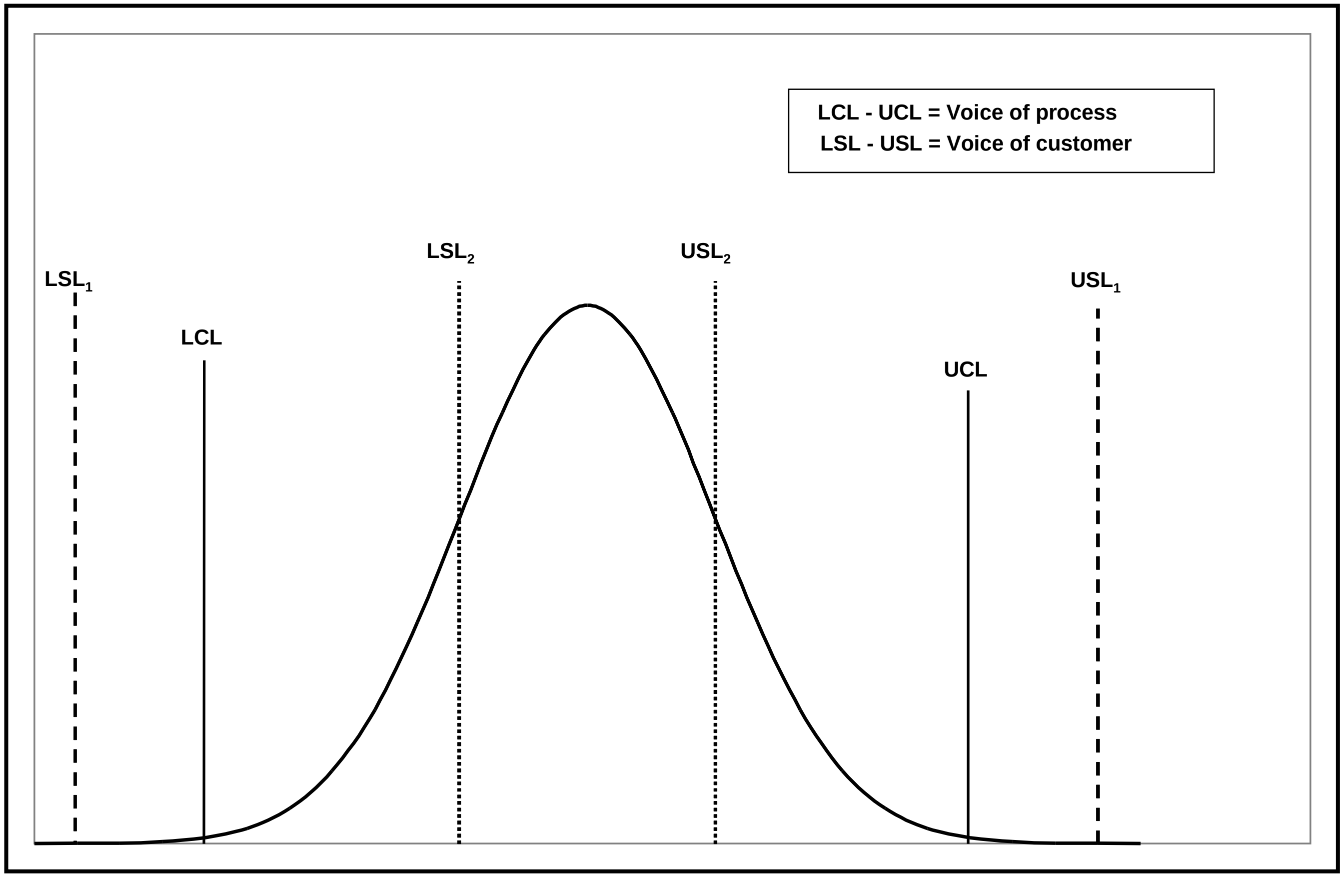
Predicting Process Performance

- **Key Questions**
  - **How do process parameters affect project productivity, cost, and schedule?**
  - **How do process parameters affect product quality?**
  - **How can I improve the process? (What is the increase in product quality if I invest more effort in design instead of testing?)**
- **Process Performance Model**
  - **Makes quantitative predictions about a particular production process**
  - **May estimate resource consumption, time delays, effectiveness, and efficiency**

Types of Process Performance Models

Type	Handles Unstable Processes?	Representation of Process Mechanisms	Examples
Statistical	No	None	Statistical process control
Functional	No	Explicit	Parametric models (algorithms based on causal mechanisms). COQUALMO and staged models.
Dynamic	Yes	Implicit (via propagation)	System dynamics models (Coupled equations embody the causal mechanisms. Solving numerically gives predicted behavior.)

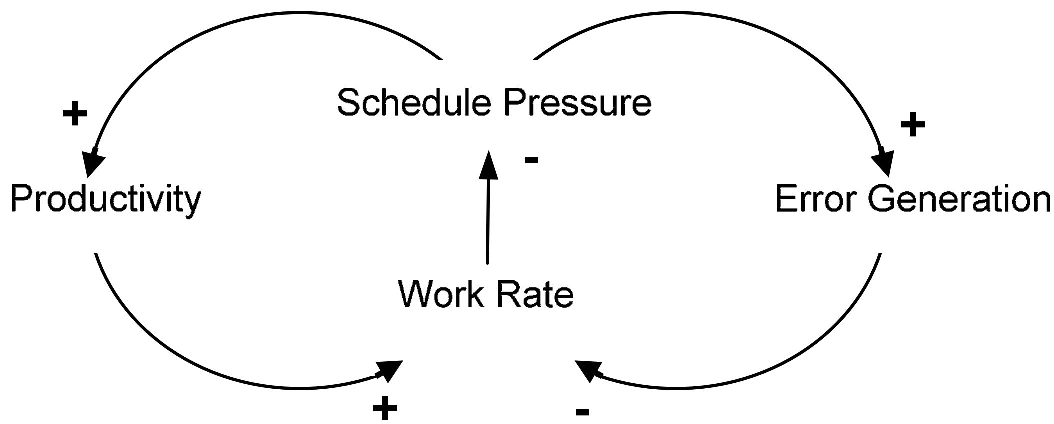
Statistical Process Control



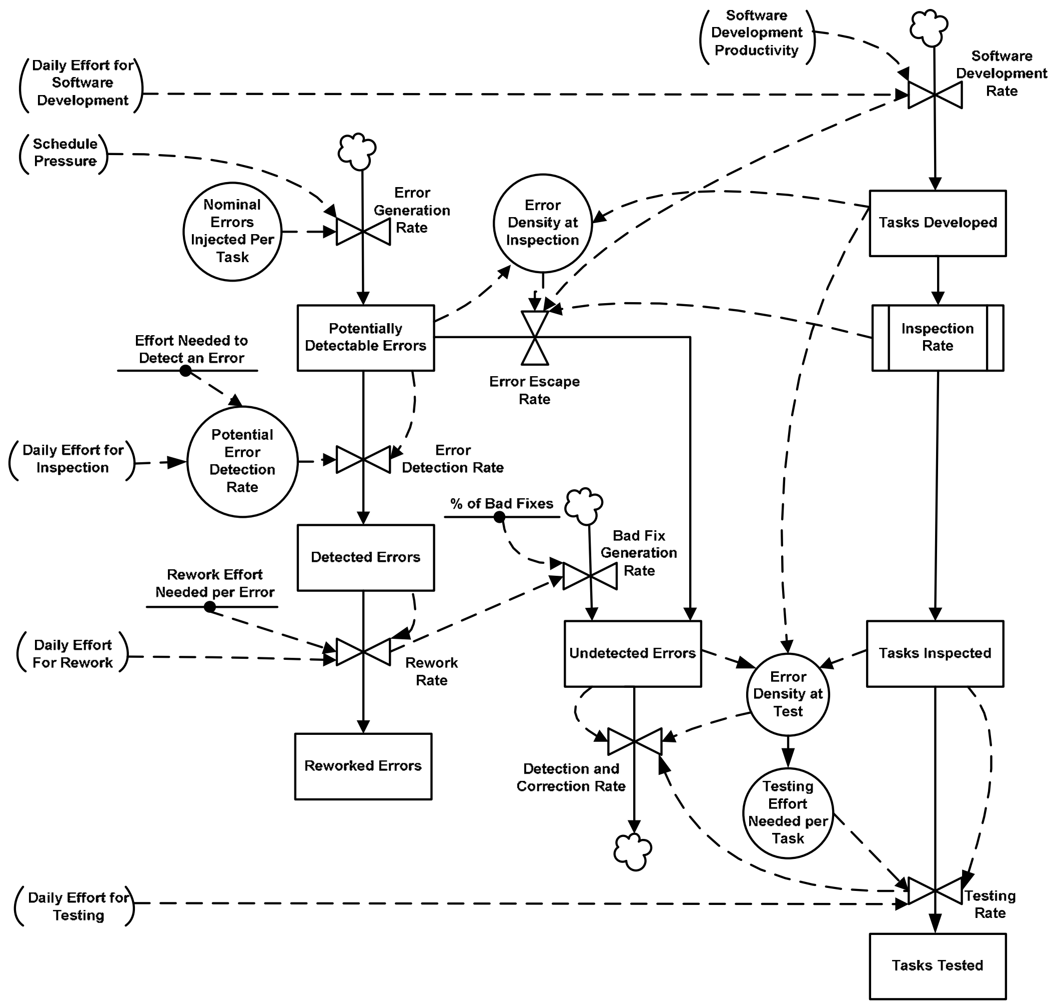
Sample Defect Leakage Matrix

	Phase Detected					
Phase Injected	**Analysis**	**Design**	**Code**	**Integ. Test**	**Alpha Test**	**Beta Test**
Analysis	98.0	6.0	12.0	14.0	27.0	18.0
Design		142.0	38.0	23.0	17.0	8.0
Code			114.0	61.0	23.0	4.0
Integ. Test				16.0	2.0	1.0
Alpha Test					2.0	0.0
Beta Test						1.0

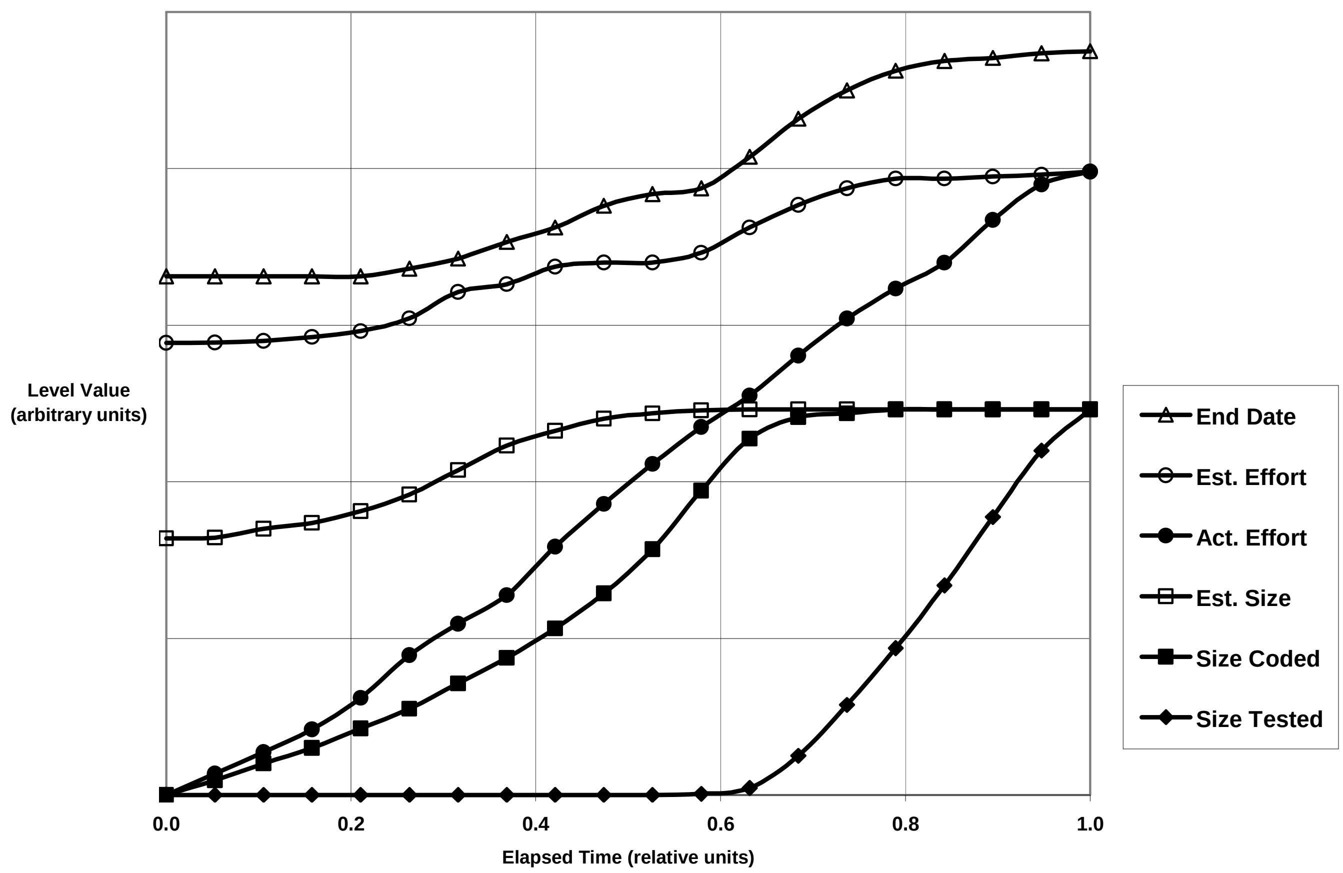
System Dynamics Model: Concept



System Dynamics Model: Relationships for CoSQ



System Dynamics Model: Sample Output



Summary

- Measures help control the production process
- The choice of process performance measures depends on organizational goals
- Predictive models supplement measures
- Predictive accuracy depends on
  - The process definition (detail, stability, tailoring)
  - The process execution (compliance, consistency)
  - The model's scope and validity (relevant factors and interactions, fidelity)

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Using SW-CMM SQA independent verification as a first step for the transition to CMMI

National Defense Industrial Association
5th Annual CMMI® Technology Conference and user Group
November 2005

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Context - CenPRA - Centro de Pesquisas Renato Archer

Brazilian Government funded Research Center on Information Technology

Research Areas: Technological Innovation, Qualification and Applications for the Society

230 researchers in 13 Technological Divisions

DMPS: Divisão de Melhoria de Processos de Software
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- Focus: Process Evaluation and Improvement
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  - Participation in technical committees of ISO/IEC 15504 and MPS.BR
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  - Training courses
- Specific Process Models development.

Motivation

- After 2005 December no more CMM appraisals will be held
- Organizations with CMM level 2 or 3 have a powerful tool for the beginning of the transition process: The independent verification of SQA

How it began

- In 2004 December, an Organization at CMM level 2 has asked us to make an independent evaluation in order to comply to CMM SQA Verification 3:
  - Experts independent of the SQA group periodically review the activities and software work products of the project's SQA group.
  - Organization's Process Manual defines that the independent evaluation would be conducted by external entity.
- Due to the near deadline of CMM retirement, we proposed to the Organization to take advantage of this opportunity to make a more comprehensive and deep verification, making a SCAMPI B based assessment and, using both CMM-SQA and CMMI-PPQA as references for the evaluation.

How it was done

- The evaluation has followed the SCAMPI phases:
  1. Plan and Prepare appraisal
  2. Conduct appraisal
  3. Report results

Activities done - Phase 1: Plan and Prepare the appraisal

- Preliminary Appraisal (1 day)
  - Objectives:
    - Understand how CMM was applied in the Organization
    - SQA preliminary appraisal
    - Define a document list for the appraisal
    - Present and discuss the appraisal format
  - Meetings with the appraisal sponsors
  - Work with SQA people
  - Initial collection of practice implementation indicators (PII)
- Appraisal Plan and preparation
  - Appraisal Plan was written by CenPRA based on the Preliminary Appraisal, reviewed and complemented
  - It defines, in compliance with the Organization Process Manual:
    - Scope and objectives of the appraisal, roles and responsibilities
    - Organization's Departments to be appraised
    - SQA process according to SW-CMM SQA and CMMI-SE/SW PPQA
  - According to SCAMPI-B (initially it was defined to be C, but during the work, it was found that the assessment could be level B)

Activities done - Phase 2: Conducting the appraisal (1,5 day)

- Appraisal done according to the Plan:
  - Organization's appraiser training
  - Opening presentation for the participants
  - Documents verification
  - Interviews: project teams, project managers, process improvement groups, SQA
  - Results compilation

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Activities done - Phase 3: Results Reporting

- Results presented to sponsors and appraisal participants.
  - SQA Process is implemented and institutionalized compliant to SQA KPA and PPQA PA; none non-conformity was identified.
  - SQA provides senior management visibility of inconsistencies, supports the execution and improvement of the processes, and helps maintaining the compliance of all processes to SW-CMM level 2.
  - In the transition to CMMI, it will be necessary to elaborate new instruments for the verification of the PA's, but the SQA process itself would be kept as is because it is compliant to PPQA
  - The SQA role is perceived as a reference and support for each one's job to comply with SW-CMM
  - The SQA Status Report presents in a clear and concise form, the results of monthly evaluations, and the corrective actions
  - There is a process and practice for process revision and improvement

Conclusions of the case study

- The existence of a very good “SQA Status Report” contributes to a comprehensive and deep insight
- Assessing the level 2 KPA’s based in this Report is a simple matter of confirmation of the verification of the Process Implementation Indicators that has been verified previously by the organization's SQA function
- **It’s possible to use the independent verification as a first step in the transition from SW-CMM to CMMI-SE/SW**

What to do
0 - Prerequisite

- The more the SQA function is well done, the more it's possible to use the SQA independent verification to identify the gaps to CMMI-SE/SW
- In the preparation phase, it is possible to have a first insight of how good is the SQA and if it is possible to apply the proposed approach
- In this case study:
  - The "SQA Status Report" reports the non-conformities for each KPA against the Goals, Commitment, Abilities, Activities, Measurements, and Verification. Based on this, the Process Implementation Indicators can be identified.
  - It's possible to extract the frequency, recurrence and trends of the non-conformities, allowing a priority analysis of the problems.
  - It is a very good instrument for the appraisal of the Level 2 PAs
- If, as in this case study, it is perceived that it would be possible to extend the objectives of the independent verification to a first gap analysis, make the plan for doing so

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What to do
1- Preparation

- Define, with the appraisal sponsor, the intention to use the SQA independent appraisal for the gap analysis
- Verify the availability of SQA instruments like that "SQA Status Report".
- If it has been concluded that there is good information, do the following activities:
  - a) Include the goal of identifying the gaps to CMMI in the Appraisal Plan
  - b) Use a SW-CMM KPA's to CMMI PA's mapping
  - c) From a "SQA Status Report" or equivalent, raise the objective evidences not only for SQA/PPQA but also for the other PA's.
  - d) Identify other Process Implementation Indicators (PII) for other PA's
  - e) Adapt the Appraisal Plan, the agenda, required resources and documents to the additional goal of identifying the gaps
  - f) In the team training, include some comparison between CMM and CMMI highlighting the differences and similarities. Include also some comparison between SCAMPI and CBA-IPI.

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What to do
2 - Conducting the appraisal

CMMI Technology Conference and User Group

- Conduct the appraisal according to SCAMPI (B or C) verifying the SQA function and the processes verified by it
- Organize the results separating the CMM issues and the CMMI issues

What to do
3 - Reporting the results

- The report will be done in two distinct parts:
  - CMM-SQA issues
  - CMMI gaps issues
- Take advantage of the closing session to explain differences between CMM and CMMI and, CBA-IPI and SCAMPI

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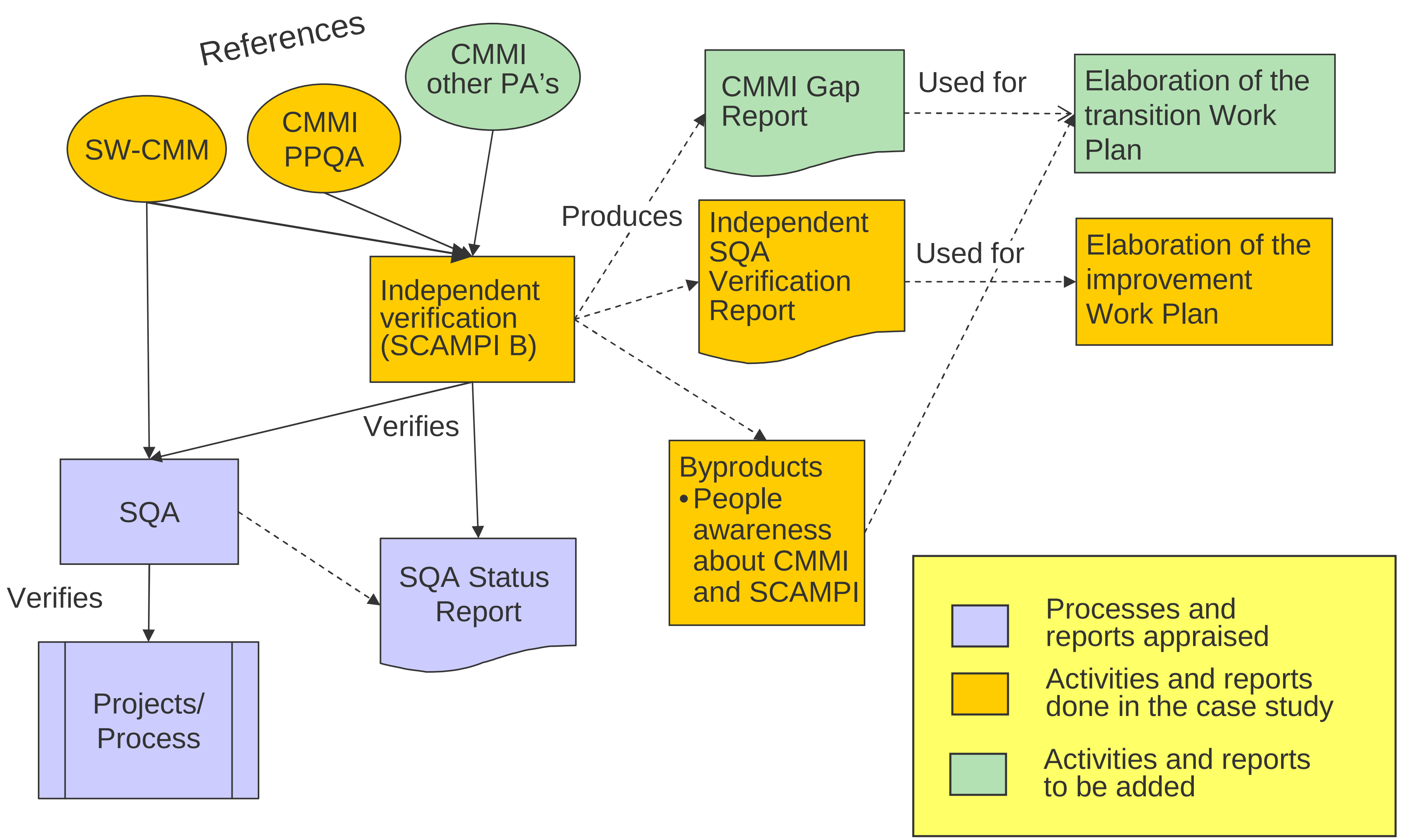
SQA independent verification used as first step for the transition to CMMI



Advantages

- First gap analysis with small increase in the appraisal costs – it can be used as input for the decision about how and when the transition will be done
- The Organization will have a contact with CMMI and SCAMPI, in a practical way, through the opening and closing sessions, and with the objective evidences gathering and the interviews
- SQA people can reformulate their instruments for their internal evaluations for a better transition support

Conclusions

- This work is an application of the “Industry as Laboratory” concept proposed by Potts [5]. The initial intent of the industry aimed to a specific necessity: to perform independent verification of SW-CMM SQA. We, from CenPRA, proposed to widen the appraisal using CMMI PPQA as reference and SCAMPI B as the appraisal method.
- The results of the appraisal indicate us the possibility of proposing an even more widening of the appraisal objectives: use the independent verification of SW-CMM SQA for the gap identification for the transition from SW-CMM to CMMI-SE/SW
- We have defined “What to do” to apply this approach
- We intend to apply this approach soon in the same organization or in another one

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Activities done - Phase 2: Conducting the appraisal (1,5 day)

- Appraisal done according to the Plan:
  - Organization’s appraiser training
  - Opening presentation for the participants
  - Documents verification
  - Interviews: project teams, project managers, process improvement groups, SQA
  - Results compilation

Activities done - Phase 3: Results Reporting

- Results presented to sponsors and appraisal participants.
  - SQA Process is implemented and institutionalized compliant to SQA KPA and PPQA PA; none non-conformity was identified.
  - SQA provides senior management visibility of inconsistencies, supports the execution and improvement of the processes**,** and helps maintaining the compliance of all processes to SW-CMM level 2.
  - In the transition to CMMI, it will be necessary to elaborate new instruments for the verification of the PA's, but the SQA process itself would be kept as is because it is compliant to PPQA
  - The SQA role is perceived as a reference and support for each one's job to comply with SW-CMM
  - The SQA Status Report presents in a clear and concise form, the results of monthly evaluations, and the corrective actions
  - There is a process and practice for process revision and improvement

Conclusions of the case study

- The existence of a very good “SQA Status Report” contributes to a comprehensive and deep insight
- Assessing the level 2 KPA’s based in this Report is a simple matter of confirmation of the verification of the Process Implementation Indicators that has been verified previously by the organization's SQA function
- **It’s possible to use the independent verification as a first step in the transition from SW-CMM to CMMI-SE/SW**

What to do
0 - Prerequisite

- The more the SQA function is well done, the more it's possible to use the SQA independent verification to identify the gaps to CMMI-SE/SW
- In the preparation phase, it is possible to have a first insight of how good is the SQA and if it is possible to apply the proposed approach
- In this case study:
  - The "SQA Status Report" reports the non-conformities for each KPA against the Goals, Commitment, Abilities, Activities, Measurements, and Verification. Based on this, the Process Implementation Indicators can be identified.
  - It's possible to extract the frequency, recurrence and trends of the non-conformities, allowing a priority analysis of the problems.
  - It is a very good instrument for the appraisal of the Level 2 PAs
- If, as in this case study, it is perceived that it would be possible to extend the objectives of the independent verification to a first gap analysis, make the plan for doing so

What to do
1- Preparation

- Define, with the appraisal sponsor, the intention to use the SQA independent appraisal for the gap analysis
- Verify the availability of SQA instruments like that "SQA Status Report".
- If it has been concluded that there is good information, do the following activities:
  - a) Include the goal of identifying the gaps to CMMI in the Appraisal Plan
  - b) Use a SW-CMM KPA's to CMMI PA's mapping
  - c) From a "SQA Status Report" or equivalent, raise the objective evidences not only for SQA/PPQA but also for the other PA's.
  - d) Identify other Process Implementation Indicators (PII) for other PA's
  - e) Adapt the Appraisal Plan, the agenda, required resources and documents to the additional goal of identifying the gaps
  - f) In the team training, include some comparison between CMM and CMMI highlighting the differences and similarities. Include also some comparison between SCAMPI and CBA-IPI.

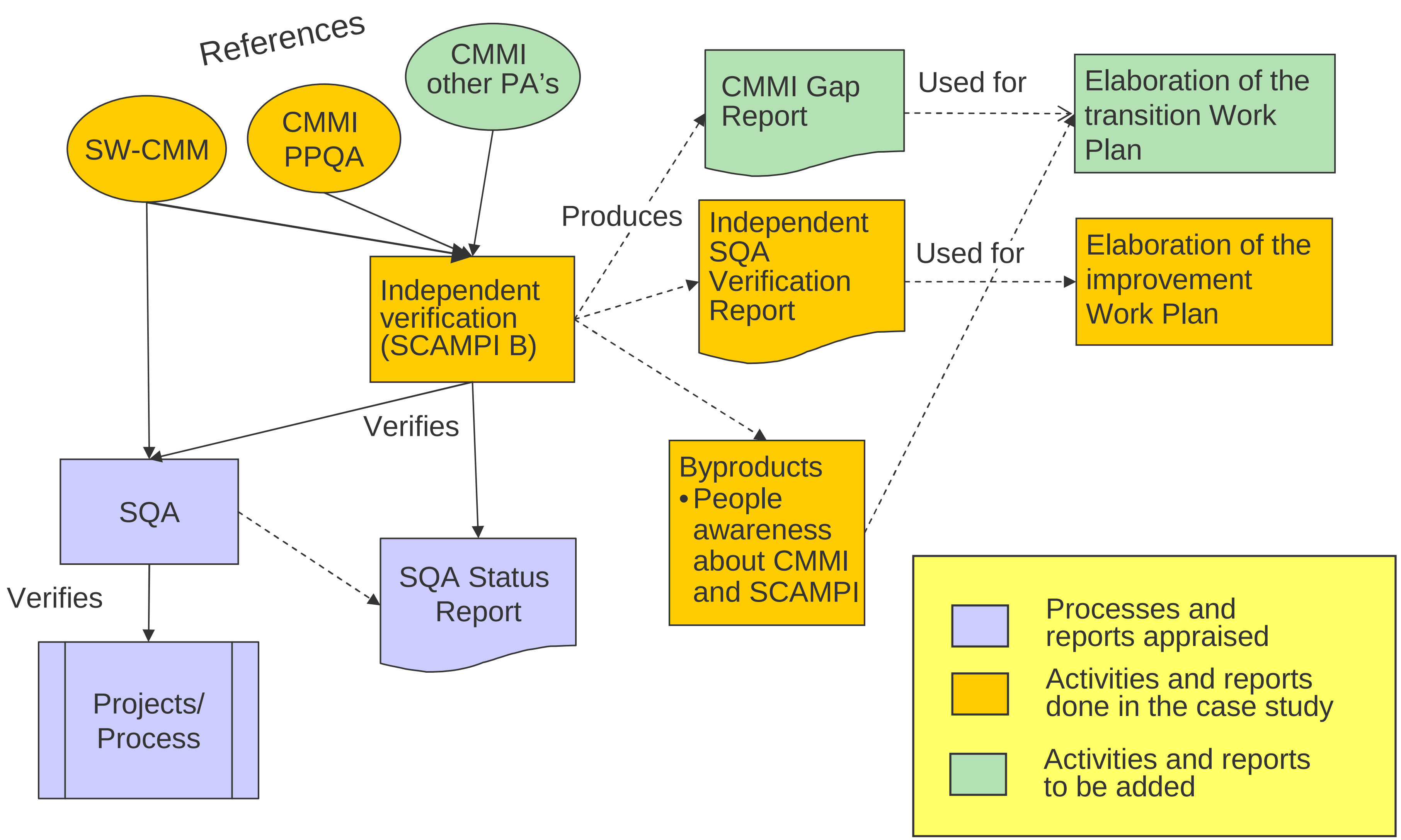
What to do
2 - Conducting the appraisal

- Conduct the appraisal according to SCAMPI (B or C) verifying the SQA function and the processes verified by it
- Organize the results separating the CMM issues and the CMMI issues

What to do
3 - Reporting the results

- The report will be done in two distinct parts:
  - CMM-SQA issues
  - CMMI gaps issues
- Take advantage of the closing session to explain differences between CMM and CMMI and, CBA-IPI and SCAMPI

SQA independent verification used as first step for the transition to CMMI



Advantages

- First gap analysis with small increase in the appraisal costs – it can be used as input for the decision about how and when the transition will be done
- The Organization will have a contact with CMMI and SCAMPI, in a practical way, through the opening and closing sessions, and with the objective evidences gathering and the interviews
- SQA people can reformulate their instruments for their internal evaluations for a better transition support

Conclusions

- This work is an application of the “Industry as Laboratory” concept proposed by Potts [5]. The initial intent of the industry aimed to a specific necessity: to perform independent verification of SW-CMM SQA. We, from CenPRA, proposed to widen the appraisal using CMMI PPQA as reference and SCAMPI B as the appraisal method.
- The results of the appraisal indicate us the possibility of proposing an even more widening of the appraisal objectives: use the independent verification of SW-CMM SQA for the gap identification for the transition from SW-CMM to CMMI-SE/SW
- We have defined “What to do” to apply this approach
- We intend to apply this approach soon in the same organization or in another one

CenPRA Centro de Pesquisas Renato Archer

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[6] SEI, A Family of SCAMPI Appraisal Methods - 2003

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NORTHROP GRUMMAN
DEFINING THE FUTURE

Journeys on the Road to Level 5

16 November 2005

Joseph V. Vandeville
Richard L. W. Welch, PhD
Northrop Grumman Corporation

AGS&BMS-PR-05-103

Agenda

- Our Process Improvement History
- The Infrastructure That Made It Work
- New Attitudes In Using Metrics
- Is Level 5 The End . . . Or The Beginning

Northrop Grumman Today

- **125,000 people, 50 states, 25 countries**
- **Largest manufacturing employer in Louisiana, Mississippi, Virginia, Maryland**
- **One of top three defense contractors**
- **Leading systems integrator**
- **Largest military shipbuilder**
- **Largest provider of airborne radar and electronic warfare systems**
- **One of two top IT providers to the U.S. Government**
- **One of three major contractors in military and civil space, missile defense**

More than $31 Billion in 2004 Sales

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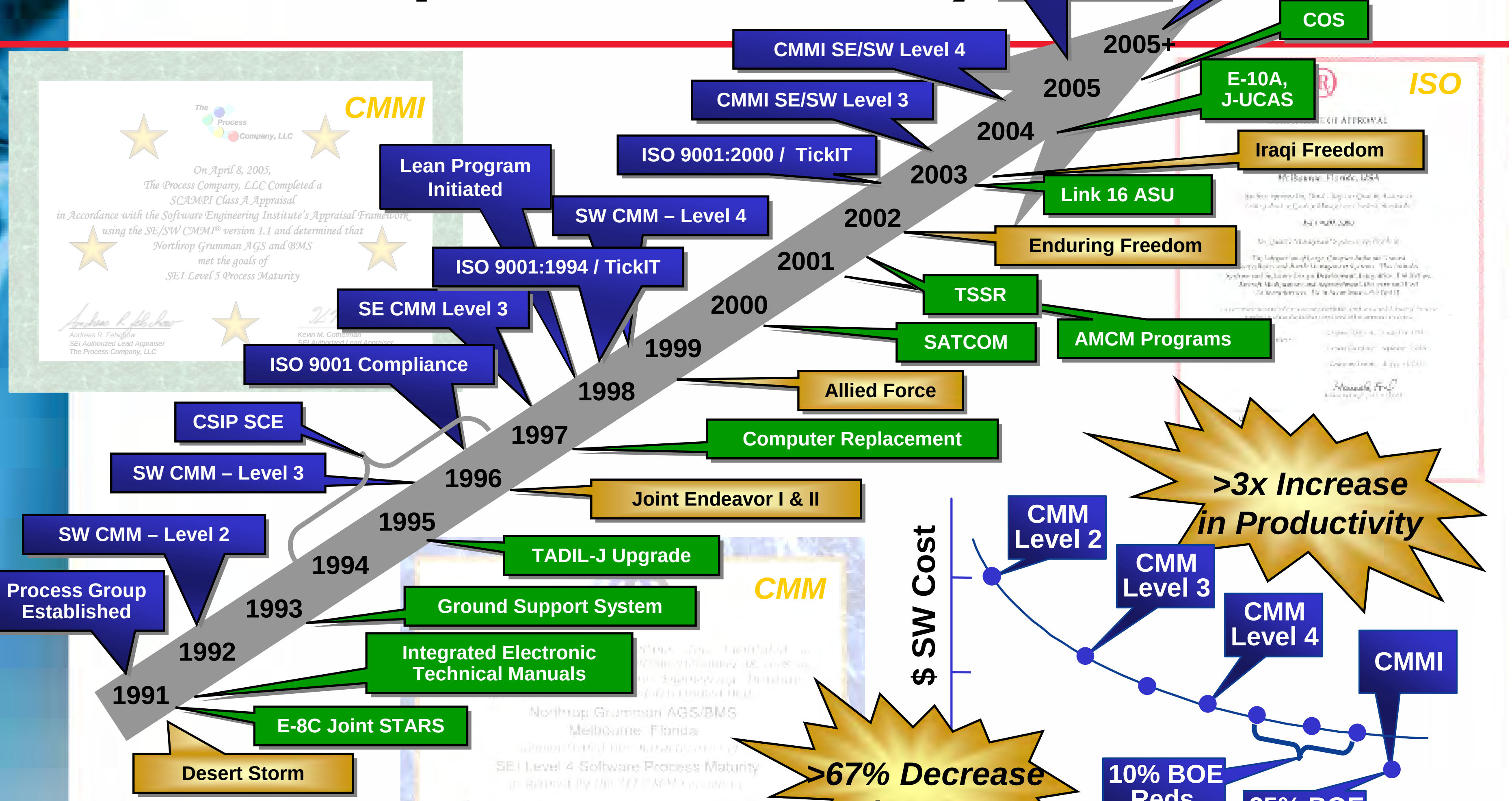
Process Improvement History



Return on Investment Demonstrated by

- ***Higher Productivity***
- ***Competitive Pricing***
- ***Improved Quality***
- ***Faster Time to Market***

Since Our Work Is Cost-Plus, These Benefits Accrue to Our Customers

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AGS&BMS-PR-05-103

Infrastructure for Innovation

Corporation & Business Area

- Corporate goals
- Business Area goals

- Status reporting

Engineering Steering Committee

- Engineering Directors
- Quality Director
- Executive Management Representative

- Direction, Guidance
- Resources
- Engineering goals, objectives

- Improvement proposals
- Process performance status reporting

Engineering Process Group (EPG)

- Full Time EPG Chairperson
- Representatives from each Engineering Directorate
- Software Quality representative
- Program and project representatives

Software Engineering Process Group (SEPG)

Software practitioners and relevant stakeholders to improve software specific processes

Process Management Teams (PMT)

Multi-disciplinary teams empowered to evaluate and continuously improve broad engineering processes

Process Working Groups

Teams established as needed

Steering Committee

- **Comprises**
  - Engineering Director
  - Directors from Each Engineering Directorate (Systems, Software, Test, Vehicle, Avionics, Logistics)
  - Quality Operations
  - Business Area Management Rep
  - Project Engineering Managers
  - Program Managers
  - Engineering Process Group
- **Meets Every Week to Review Process Improvement Status with EPG and Project Practitioners**
- **Government Reps Invited to Meetings**

Engineering Process Group (EPG)

- Made Up of Process Definition and Management Personnel in Each Engineering Directorate
- Facilitates Process Improvement across the Engineering Department
- Maintains Process Assets for Use by the Organization
- Coordinates with Organizations Outside of Engineering to Ensure Proper and Efficient Process Interfaces
- Facilitates Compliance with Appropriate Process Standards and Models (E.G., ISO 9001, CMMI)
- Manages Engineering Process Management Teams
- Develops and Maintains Relationships with Universities, Research Labs and Related Consortia to Support Engineering Goals

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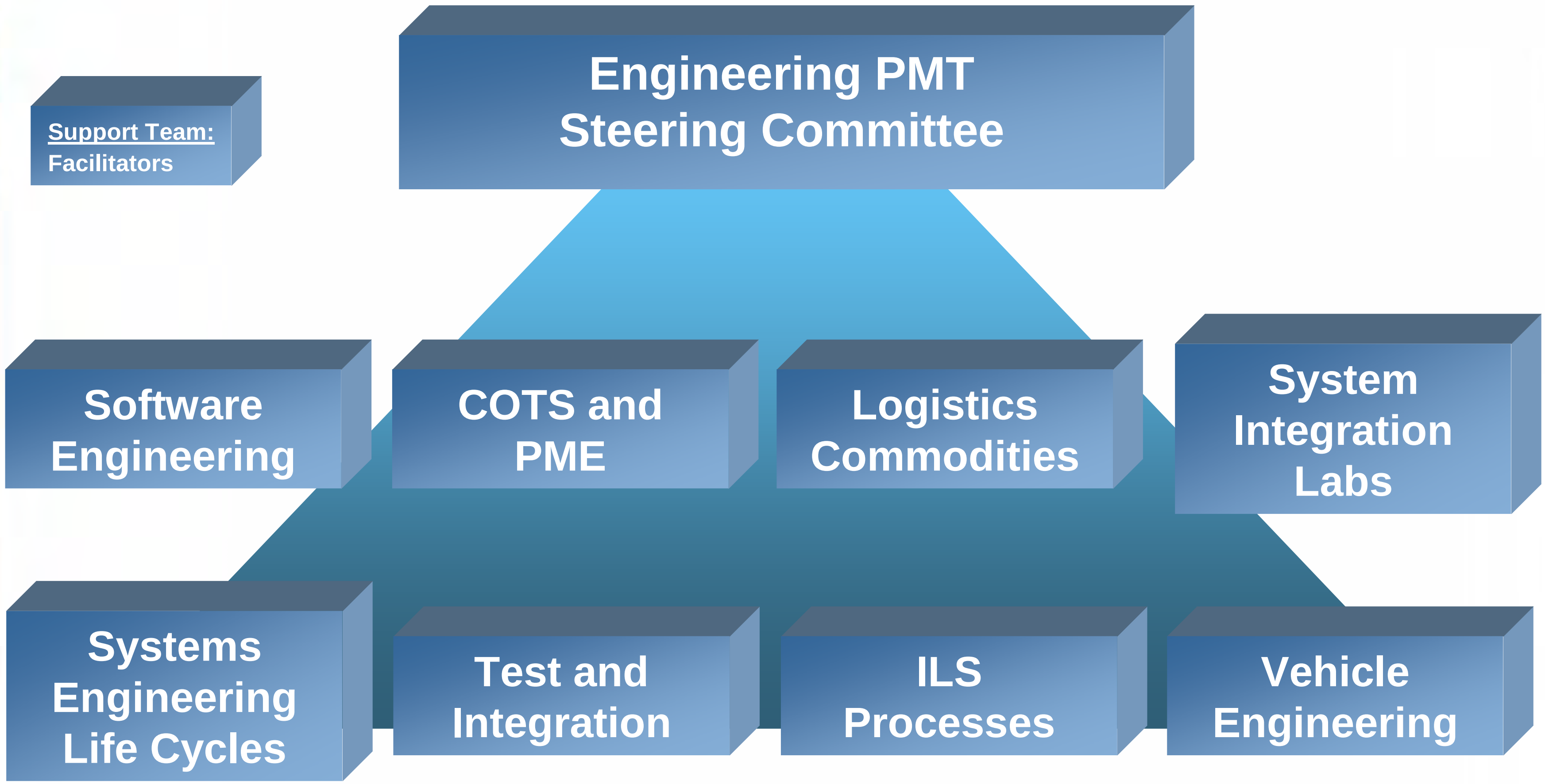
Process Management Teams

Focusing Lean on Significant Issues



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Engineering PMTs – General Goals

- **Map Process Value Stream for the Production of Relevant Products**
- **Determine Non-Value Added Activities**
  - Recognize That Some of These May Be Required by Customers or Business Needs
- **Identify Issues or Concerns Regarding the Process or Product**
  - Execute Causal Analysis & Resolution Process As Needed
- **Determine Alternatives to the Current Way of Doing Business**
  - Propose “Best” Alternatives in Terms of Cost, Schedule, Quality or Productivity Improvements
- **Present Alternatives to Steering Committee for Selection for Implementation**

CMMI Higher Levels – Differences in Behavior

At Level 3…..

- Management Reacts
  - Comparative Rather Than Statistical Analysis
  - Process Capability Not Understood
- Measurement Program
  - Data Available for Analysis
  - Analysis at Project Level
  - Data Quality Often Still a Concern

At Level 4…..

- Management Anticipates
  - Predicting Results of Critical Processes
  - Evaluating Outcomes Relative to Capability
- Measurement Program
  - Data Relied on for Decision-making
  - Data Analyzed at Organization and Project Levels

At Level 5…..

- Management Performs "Pre-emptive Strikes"
  - Identifying & Removing Systemic Process Issues
  - Predicting Results of Innovative Improvements
- Measurement Program
  - Data Relied on for Cost/Benefit Analysis
  - Benefits Forecasted for Technology or Process Optimization

Using Metrics for Higher Maturity

- **Estimating**
  - Base Estimates Of Future Performance On Past Performance
- **Project Planning**
  - Determine Resources Needed For Project Execution
- **Project Tracking**
  - Determine Whether Actual Performance Matches Predictions

Higher Maturity Uses of Metrics

- **Quantitative Management**
  - Determine Whether Project Objectives Are Likely To Be Met
- **Process Improvement**
  - Determine Whether Process Changes Have Improved Performance

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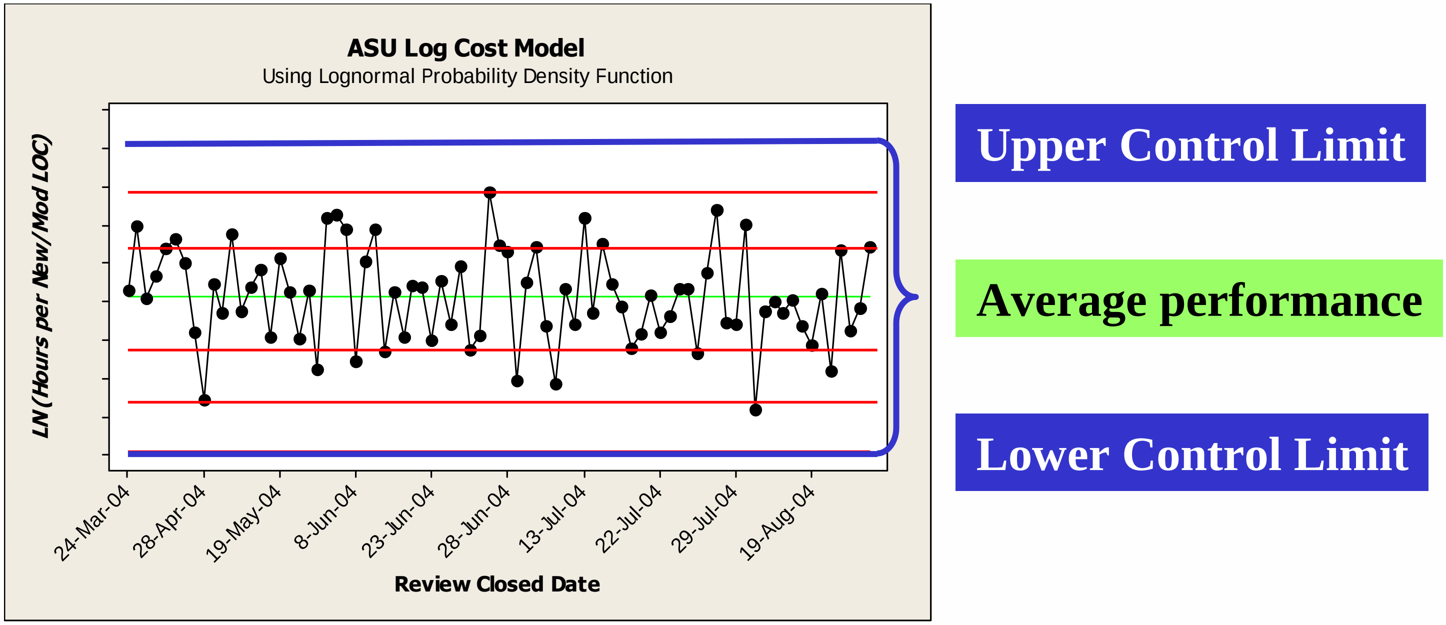
Voice of the Process

Quantitative Sub-Process Management



- **A Stable Process**
  - Operates Within the Control Limits 99.7% of the Time
  - Meets Budget
  - Offers Opportunities for Systematic Process Improvement

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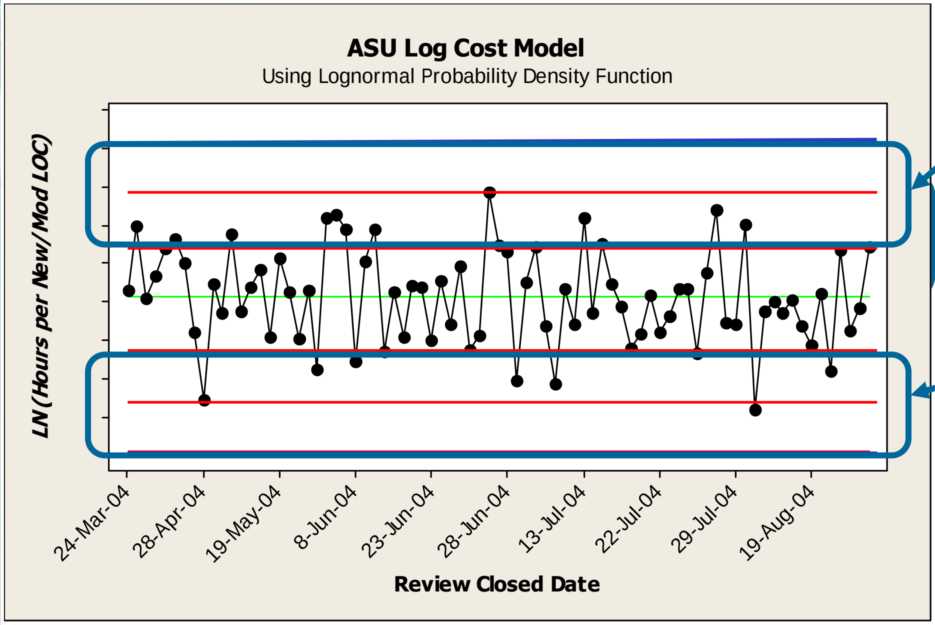
Improving the Process



Peer Reviews Greater Than 1 Standard Deviation Above the Average of Peer Review Performance

Peer Reviews Greater Than 1 Standard Deviation Below the Average of Peer Review Performance

Question: Is There a Common Cause for the Variation in Either of These Two Sub-populations of the Peer Review Data?

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Develop Candidate Solutions (Example)

Proposed Solution	Comments for Evaluation
Count the actual code reviewed (vs. just new or modified code)	This is a potential BOE issue and needs criteria for setting boundaries for code to be reviewed
Increase the complexity factor for small reviews	For 2 or less SLOC/unit set complexity to "10". For other small reviews this may need a "calibration chart" to determine appropriate complexity factors
For small reviews, select a different verification method	The different verification method will need definition. Q: Are these all Engineering Checks? More analysis may be needed.
Automate the administrative work Required to set up peer reviews (e.g., create diff files, place files into a directory/CMS, . . .)	This change would impact all reviews – not just the sub-population. Need to evaluate the impact to the overall population

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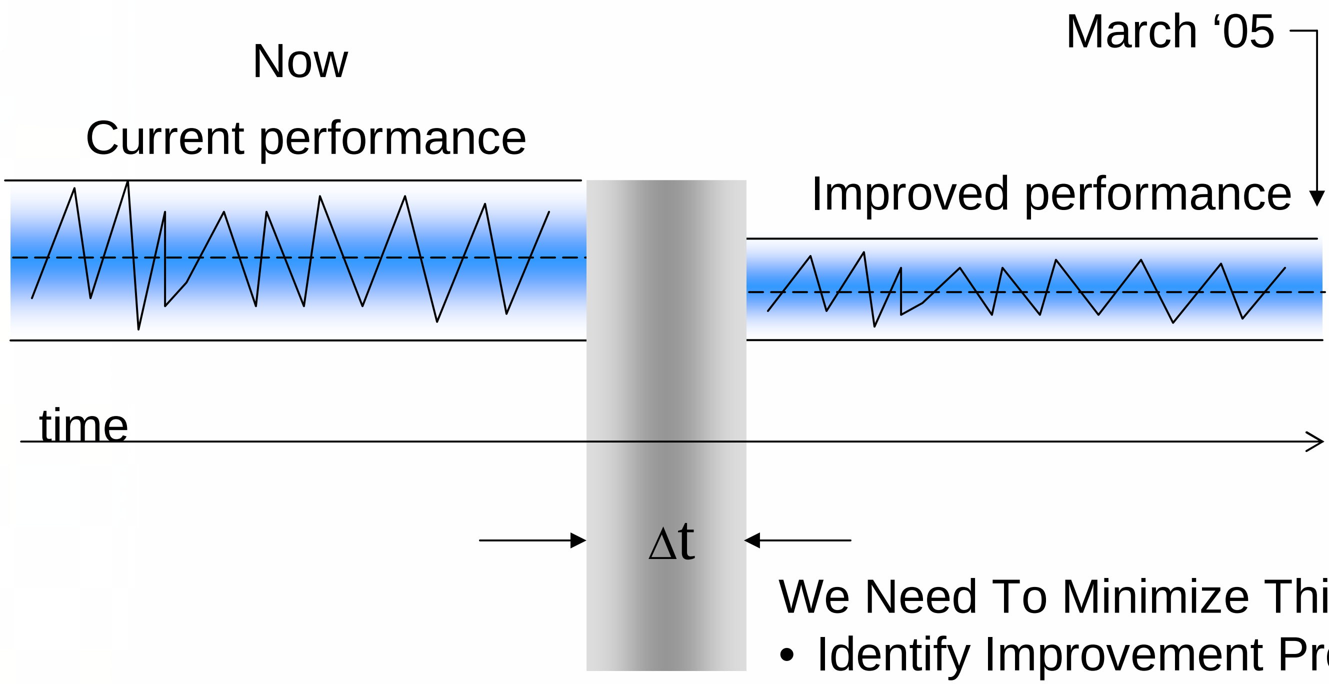
Improvement in Process Performance



We Need To Minimize This Time:

- Identify Improvement Proposals
- Evaluate & Prioritize Proposals
- Select Improvement
- Pilot Improvement
- Deploy Improvement

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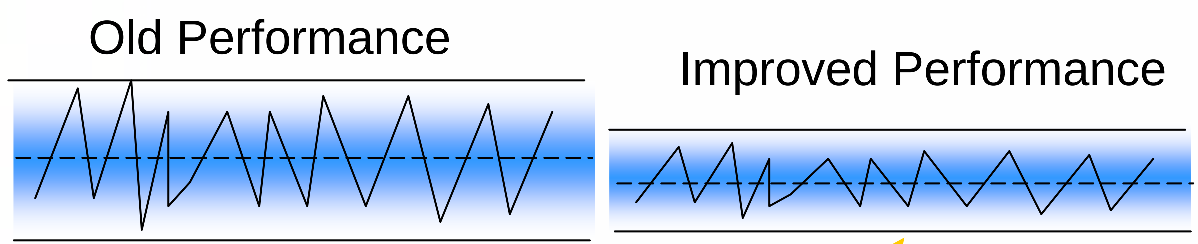
Deploying Improvements

- Publish a New Organization Baseline for the Improved Process
- Deploy New Process Objectives To Project
- Deploy New Process To Project
- Monitor New Process Performance Against New Capability

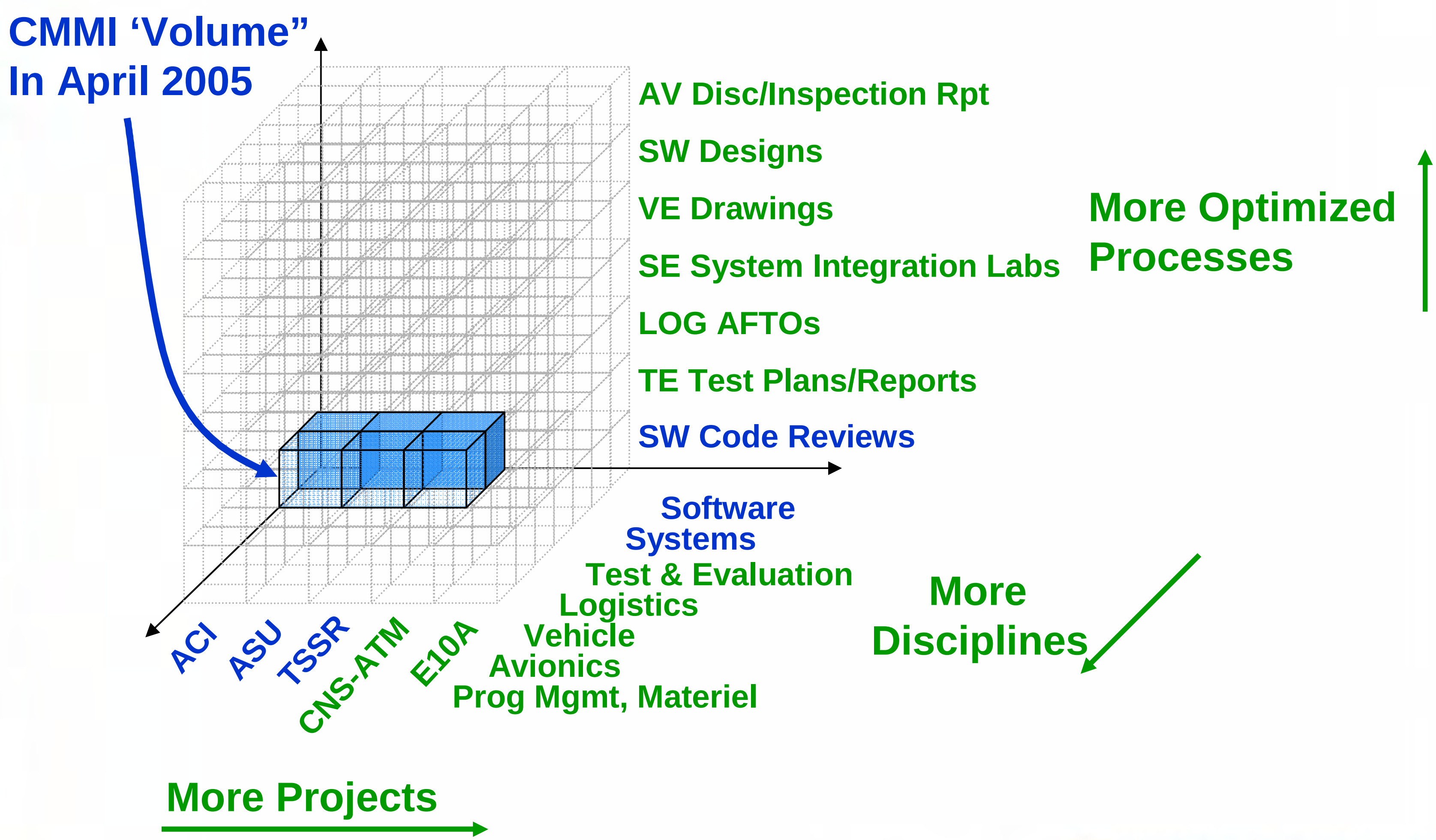


58 – 75% Reduction in Variation

10 – 14% Reduction in Cost

Growing the Capability

What happens after Level 5 . . .



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QUESTIONS

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Raytheon
Customer Success Is Our Mission

Creating Helpful Process Directives

Ken Weinberg
El Segundo, CA
kiweinberg@raytheon.com

November 16, 2004

Three Facets to Effective Directives

- Directive System Architecture
- Structure of Directives within Architecture
- Writing Style of Each Directive

Each part compliments the other

Raytheon

One Set of Directives

- Medium/Large Programs
- Small Projects
- Research Programs
- Engineering Services

Goal: Develop a Single Directive System Scalable to Accommodate Diverse Types of Typical Programs

Directive System Architecture

Procedures	Directive/ Non-Tailorable	High Level Directly Traceable to CMMI, ISO, Corp Stds
Work Instructions	Directive/ Tailorable	Lower Level, Further Direction on “How” to Meet Requirement
Enablers	Non-Directive	Guidelines/ Templates

Project and Organization level Directives are Separate

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Directive Structure

1. Document Information
2. Interfaces
3. Inputs/Outputs
4. Definitions
5. Instruction
6. Requirements
7. Revision History

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Document Information

- Administrative – Document Number, Date, Revision
- Summary - No more than two sentences
- Intended Users
- Stakeholders
- Interfaces (Optional in Enablers)
  - Identify Referenced Documents by Document Number, Document Title, and Directive Type
- Inputs/Outputs (Optional in Enablers)
  - Inputs - Any conditions, materials, requirements, or outputs of other processes necessary to begin the process
  - Outputs - all outputs of the process to which the document relates, including deliverable products, or products that require storage in a project or organizational database or repository
- Definitions (Optional in Enablers)
  - Terms specific to the organization or the directive system; and terms whose meaning differs from the common dictionary meaning.
  - Hyperlink to its Definition in the Glossary

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Instruction

- Provide a narrative description that tells users how to execute the process.
  - Amplifies the Requirements
  - Adds Explanatory or Tutorial Information
  - Places the Process and its Requirements in a Coherent Narrative
- Identify requirements in bold type.
- Keep the directives as concise as possible.
- Where possible, make the process scalable to account for projects of different sizes and types.

Requirements

- Table That Lists Each Requirement
  - Core of a Procedure or Work Instruction
  - Not part of enablers
  - Assigns a Unique Number to Each Requirement
  - Maps Each Requirement to a Narrative Paragraph
- Programs and Organization are Responsible Only for Complying with the Requirements in the Table (As Tailored)
- Table Used as Input for Tailoring Tool
- Objective Evaluation Checklists Derived from Table

Writing Style

- Document naming conventions
- Discipline specific Directives begin with the discipline designation (i.e., “Program Management”, “PM”, “Software”, “SW”, etc.)
- Spell out the first use of acronyms and abbreviations
- Refer to directive documents by hyperlinked document number, italicized title, and directive type

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Writing Style - continued

- The first sentence of each paragraph identifies the responsibility for that paragraph
- *active voice, present tense, indicative mood*—“who does what.”
- Identify by role the responsible person or team; do not use “the project” or “the organization.” Do not state that someone “ensures” or “assures” that something happens unless the requirement is strictly a verification function.
- If the same people are responsible for the entire document, identify the responsibility in the first paragraph; write the rest of the document in “directive” style.

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Writing Style - continued

- Directive
  - Subsequent sentences in the paragraph provide directive instructions. Use the *active voice, present tense, imperative mood* -- begin with an action verb.
  - Examples: “Prepare the charts using the format in Appendix B.” “Submit comment sheets to the review scribe.” “Update the sizing estimates monthly.”
- Explanatory
  - If any further information is needed to explain a directive, use the *active voice, present tense, indicative mood*.
  - Example: “Sizing includes measured and projected usage.”

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Avoid …

- Passive voice. Instruct the reader to “do something” rather than stating that “something is done.”
  - Example: “The technical lead reviews the documents. The reviewers each record their comments on the comment sheets. The review team assigns action items.”
  - Rather than “Documents are reviewed, comments are recorded on comment sheets, and corrective action is assigned.”
- “*perform.*” Use an imperative verb that defines what to do.
  - Example: “Tailor” instead of “Perform tailoring activities.”; “
  - Objectively evaluate the process” instead of “Perform objective evaluation of the process.”
- “*the following*.” Omit or use an imperative verb. Example: “Consider:” instead of “Consider the following.”
- “*in accordance with*.” Use “*according to*” to specify a directive document with which a requirement complies. Example: “Analyze the data according to EI-98-45,
- “*personnel*.” Identify the actual role. Example “The Program Configuration Management representative controls the work product list” instead of “Configuration Management personnel control the work product list.”
- “*in order to*.” Use “*to*”. Example: “Reviewers complete comment sheets to record their comments.” instead of “Reviewers complete comment sheets in order to record their comments.”
- “*prior to*” (or “*prior*”). Use “*before*,” which means the same thing.
- “*utilize*.” Use “*use*.”
- “*On a … basis*.” Specify the time interval. Examples: “Publish the report monthly” instead of “Publish the report on a monthly basis.”
- “*activity*” when referring to an individual, team, or organizational entity. Specify the entity.

Summary

- Goals
  - ISO/AS9100, Corporate Standards, CMMI model compliant, as scoped
  - Single, user-friendly directive system
- Method
  - Use generic wording where possible
    - Create a Facilities Plan ➔ Document Facility Planning
    - SOW ➔ Tasks
  - Keep it short and simple ➔ really short and simple
  - Rely heavily on non-directive templates and guidelines
- Three Facets to Effective Directives
  - Directive System Architecture
  - Structure of Directives within Architecture
  - Writing Style of Each Directive

Raytheon

Questions ? ? ?

NORTHROP GRUMMAN
DEFINING THE FUTURE

Logarithms Can Be Your Friends

Controlling Peer Review Costs

November 16, 2005

Richard L. W. Welch, PhD
Chief Statistician
Northrop Grumman Corporation

Topics

- Business Objectives
- CMMI Requirements for Sub-process Control
- Why Peer Reviews?
- Data Characteristics and Difficulties
- Log-Return Model / Log-Cost Model
- The Lognormal Distribution
- Our Code Walkthrough Data on Logs
- Expanding the Capability
- Summary

Enhancing Joint STARS Capabilities

ISO / TickIT


CERTIFICATE OF APPROVAL

This is to certify that the Quality Management System of:

Northrop Grumman AGS & BMS
Melbourne, Florida, USA

has been approved by Lloyd's Register Quality Assurance
to the following Quality Management System Standards:

ISO 9001:2000

The Quality Management System is applicable to:

The Integration of Large, Complex Airborne Ground Surveillance and Battle Management Systems. This includes Systems and Software Design, Development, Integration, Production, Aircraft Modification and Refurbishment, Delivery and Post Delivery Services, All in Accordance with TickIT.

This certificate is valid only in association with the certificate schedule bearing the same number on which the locations applicable to this approval are listed.

Approval
Certificate No: LRQA 0110692

Original Approval: August 14, 1998
Current Certificate: September 1, 2004
Certificate Expiry: August 31, 2007

Issued by LRQA, Inc. Houston

This document is subject to the provision on the reverse

CMMI L5


The Process Company, LLC

On April 8, 2005,
The Process Company, LLC Completed a
SCAMPI Class A Appraisal
in Accordance with the Software Engineering Institute's Appraisal Framework
using the SE/SW CMMI® version 1.1 and determined that
Northrop Grumman AGS and BMS
met the goals of
SEI Level 5 Process Maturity

Andreas R. Felschow
SEI Authorized Lead Appraiser
The Process Company, LLC

Kevin M. Cotherman
SEI Authorized Lead Appraiser
The Process Company, LLC

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CMMI Higher Levels – Differences in Behavior

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  - Predicting Results of Innovative Improvements
- Measurement Program
  - Data Relied on for Cost/Benefit Analysis
  - Benefits Forecasted for Technology or Process Optimization

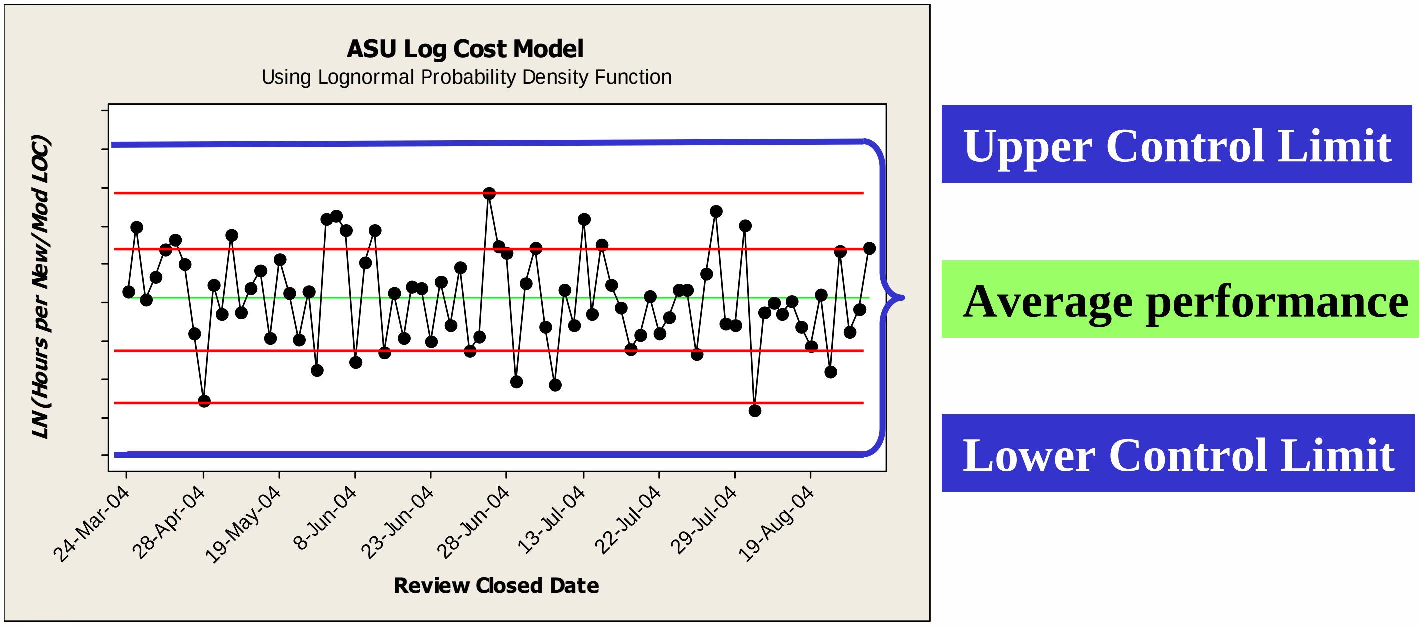
Quantitative Management

CMMI Level 4

- **Establish an Organizational Baseline and Models of Process Performance**
  - Average Performance (Effort, Duration, Quality, …)
  - Range of Performance Variation
  - Contribution of Sub-process Performance to Higher Level Processes
- **Manage Project To Achieve Quantitative Process Performance Goals**
  - Establish Project Goals Based on Organizational Performance
  - Select Sub-processes To Quantitatively Manage
  - Demonstrate Quantitative Control
  - Identify and Correct Special Causes of Performance Variation
  - Feed Data Back to the Organization

Voice of the Process

Quantitative Sub-Process Management



- **A Stable Process**
  - Operates Within the Control Limits 99.7% of the Time
  - Meets Budget
  - Offers Opportunities for Systematic Process Improvement

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AGS&BMS-PR-05-104

Why Peer Reviews?

- **Ubiquity**
  - Many Work Products Reviewed Throughout Software Development Life Cycle
    - Design Artifacts
    - Code
    - Test Plan, Procedures & Reports
- **Frequency**
  - High Data Rates
- **Influence**
  - Approximately 10% of the Software Development Effort Is Spent on Peer Reviews and Inspections
  - Code Walkthroughs Represent Biggest Opportunity

Prior State

SW-CMM Level 4

- **Software Development Baseline Characterized by Life Cycle Phase**
  - SW Requirements-Design-Code & Verification-SW Integration-System Test
  - 10+ Year Process Improvement Record Resulted in Costs Reduced by Over 67%
- **Lower Level Elements Tracked and Managed with Earned Value System**
- **No “Above the Shop Floor” Experience with Statistical Sub-process Control**
- **Issues with Peer Review Quality**
  - Inconsistent Data
  - Superficial Results

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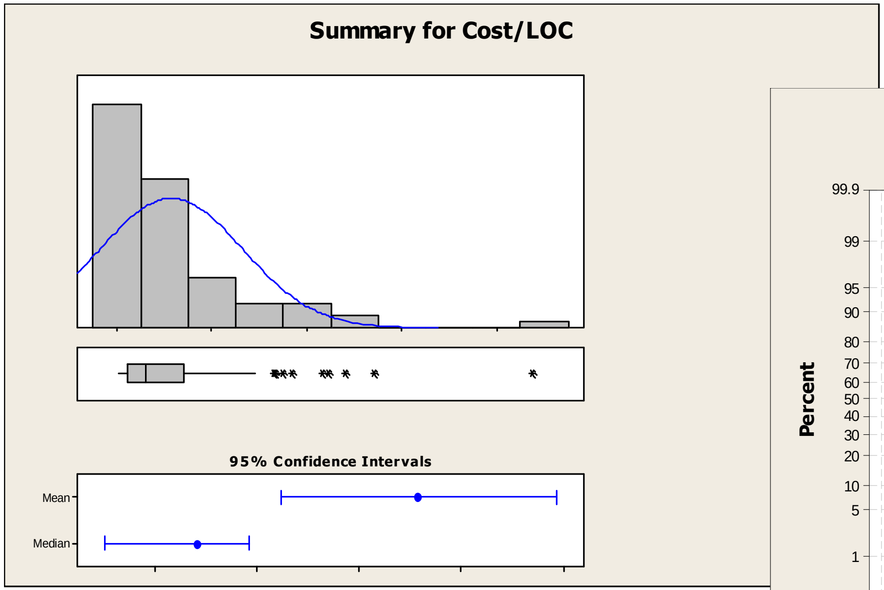
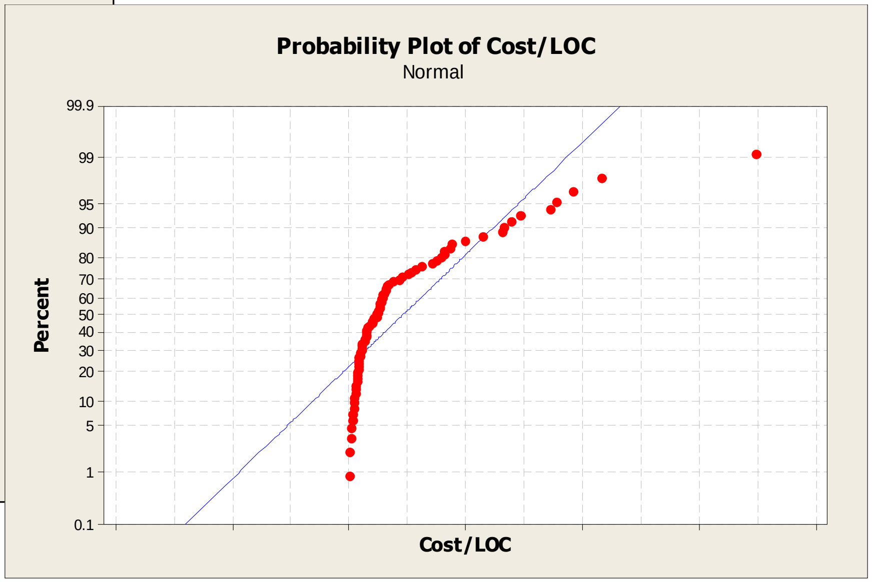
Data Characteristics

Raw Data





Andersen-Darling Test p < 0.005

Data Non-normality Violates Probability Model

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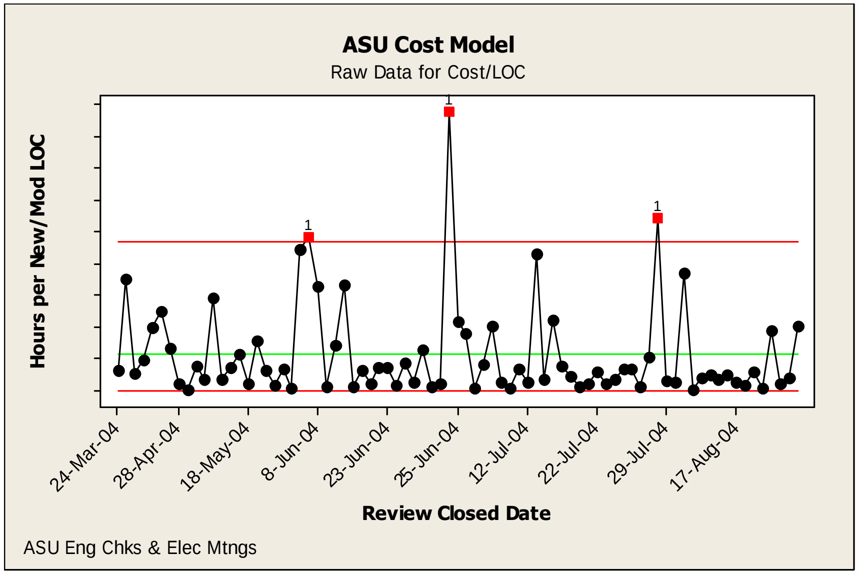
Can Code Walkthroughs Be Controlled?



- **Difficulties**
  - 11% False Alarm Rate (Chebyshev's Inequality)
    - *Penalizes Due Diligence in Reviewing Code*
  - No Meaningful Lower Control Limit
    - *Does Not Flag Superficial Reviews*
  - Arithmetic Mean Distorts the Central Tendency
    - *Apparent Cost Will Not Meet Budget*

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Log-Return Model

Stock Sales

- **Consider a stock sale in terms of the number of shares sold for a certain price**
- **The natural logarithm of the difference between the current and the next per share sale price is normally distributed with zero mean and a constant standard deviation**
- **Cost basis**
  - $s per Share Stock Price

Log-Cost Model

Peer Reviews

- **Consider a code walkthrough in terms of the number of lines of code reviewed in a certain number of hours**
- **By analogy, the natural logarithm of the difference in cost between the current and the next peer review will be normally distributed with zero mean and a constant standard deviation**
- **Cost Basis**
  - Hours per Line of Code Reviewed

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Consequences

Log-Return Model

Stock Sales

- Stock prices themselves are lognormally distributed
- The natural logarithms of stock prices follow a normal distribution
- Thus, the log-return data meet the assumptions needed for successful control charting

Log-Cost Model

Peer Reviews

- Peer review costs are lognormally distributed
- The natural logarithms of the peer review costs follow a normal distribution
- Thus, the log-cost data meet the assumptions needed for successful control charting

Math Details

- **Consider a stochastic process . . ., X_{-2}, X_{-1}, X_0, X_1, X_2, . . . that represents an asset price recorded over time, like a daily sequence of prices for shares of a stock or other commodity**
- **We assume at time t that the realization x_t of X_t is known, but the realization x_{t+1} of X_{t+1} is unknown**
- **The single-period log-return, $ln(X_{t+1}/x_t)$, is random and assumed to be normally distributed, at the given time t**
- **Under these assumptions, X_{t+1}/x_t is a lognormally distributed random variable, and therefore, so is X_{t+1}**

Math Details extracted from:
http://www.riskglossary.com/articles/lognormal_distribution.htm

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Salient Properties of the Model

- **When log-returns are normally distributed, the corresponding prices are lognormally distributed**
  - This model “is one of the most ubiquitous models in finance”
- **The distribution of log-returns and share prices have been validated empirically by many market studies accessible on the web**
- **For short time periods in a stable market, the mean return is 0**

Quotation from:
http://www.riskglossary.com/articles/lognormal_distribution.htm

Lognormal Density Function

$$f(x) = \begin{cases} \dfrac{\exp\left(-\dfrac{1}{2}\left(\dfrac{\ln(x)-\mu}{\sigma}\right)^2\right)}{x\sigma\sqrt{2\pi}} & x > 0 \\ 0 & x \le 0 \end{cases}$$

$$X \sim \Lambda[\mu,\sigma^2] \qquad Y = \ln(X) \sim N[\mu,\sigma^2]$$

$$E(X) = \exp(\mu + \sigma^2/2)$$

$$Var(X) = \left(\exp(\sigma^2) - 1\right)\exp(2\mu + \sigma^2)$$

Math details can be found in any standard mathematical statistics reference, see for example, http://en.wikipedia.org/wiki/Lognormal_distribution.

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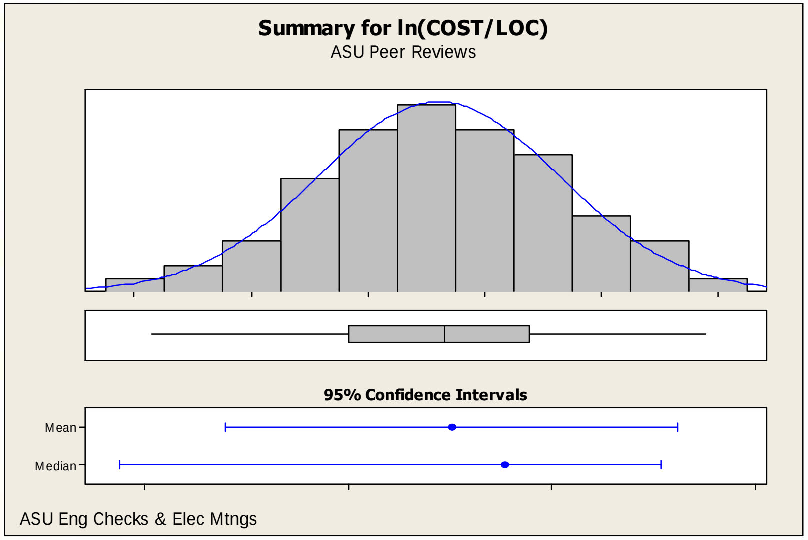
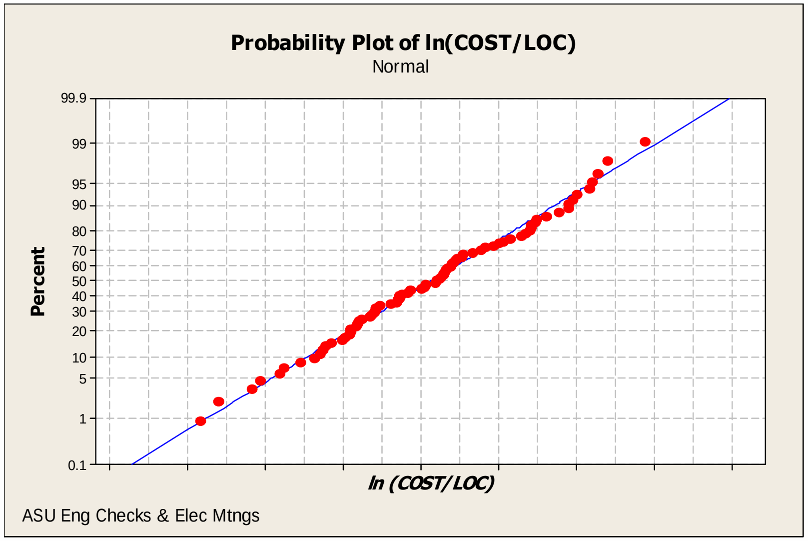
Our Data on Logs





Andersen-Darling Test $p < 0.759$

A Textbook Demonstration

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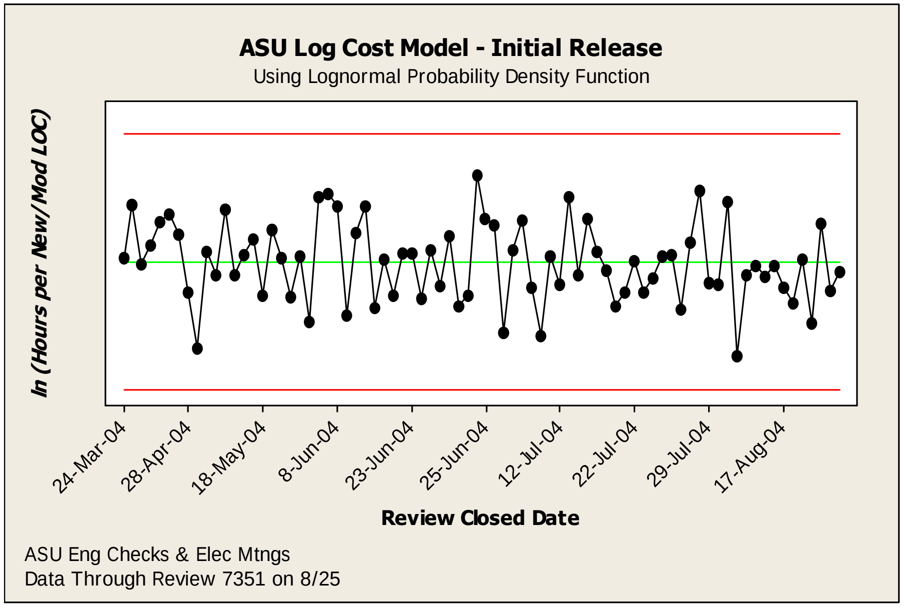
The Transformed Control Chart

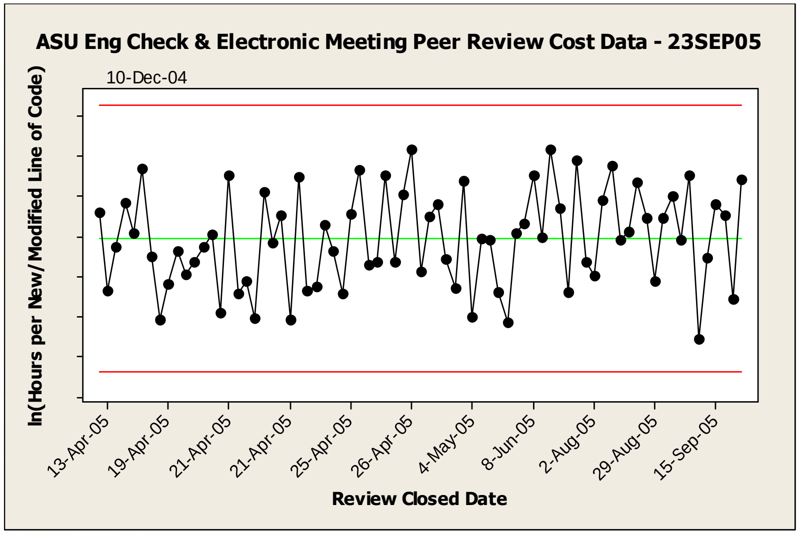


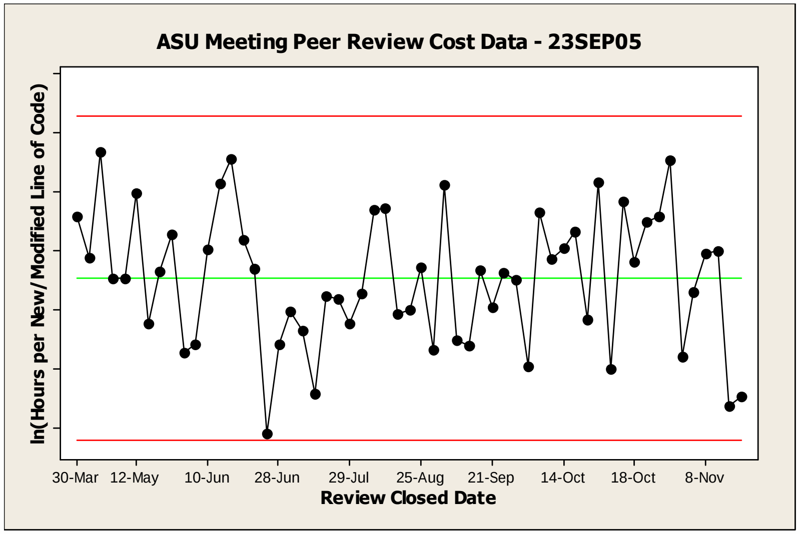
- **Impacts**
  - False Alarms Minimized
  - Meaningful Lower Control Limit
  - Geometric Mean Preserves the Budget
    - *OK, You Still Have to Find the Antilog*

An In-control, Stable Process

One Year Later . . .

- **Independent Lead Appraisers Cited Innovation and Novelty of Log-cost Model in Level 4 (10/2004) and Level 5 (4/2005) Appraisals**





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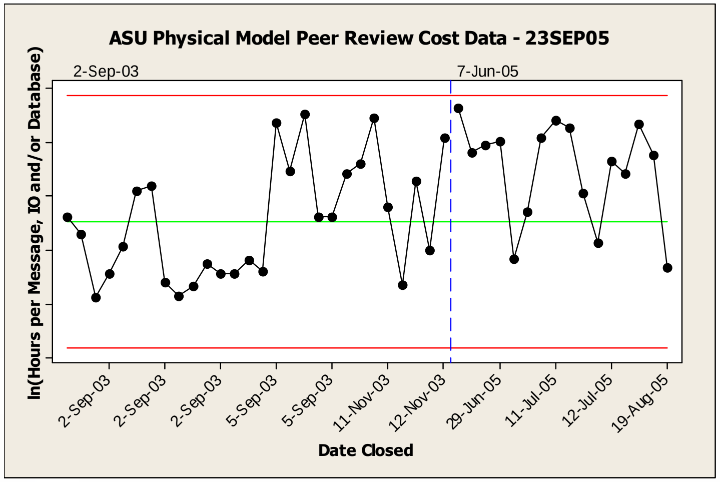
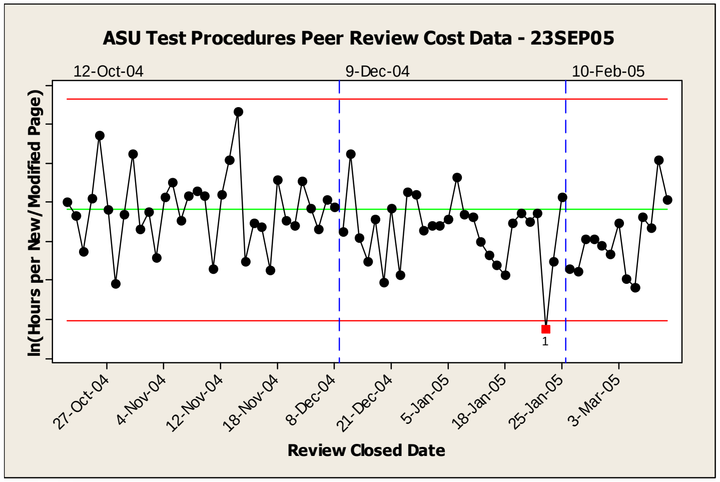
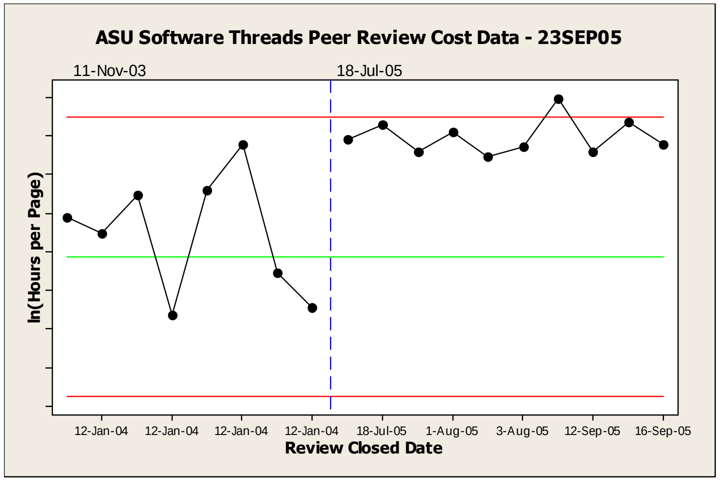
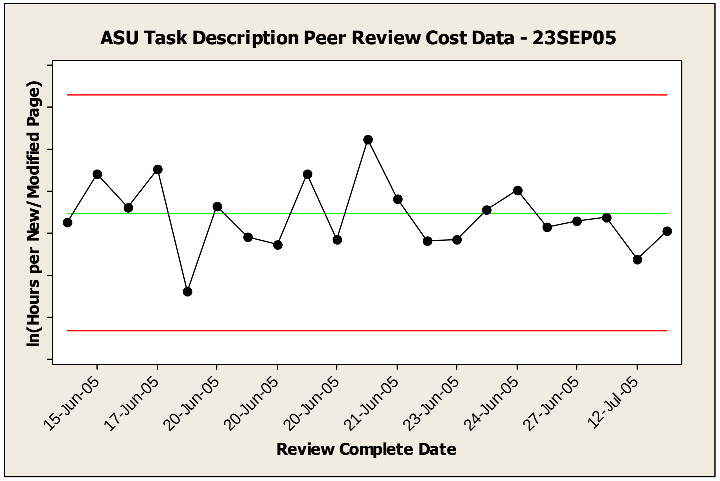
Expanding the Capability

- Test, SW Design









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Summary

With the Log-cost Model

- ***Peer Review Subprocesses Are In-control and Capable* of Meeting Baseline Budget Allocations**
- ***Due Diligence Is Rewarded***
- ***Superficial Reviews Are Detected***
- ***False Alarm Rate Reduced***
  - *Greater Than 40× Improvement*

Enhanced Sub-Process Control for CMMI Levels 4 and 5

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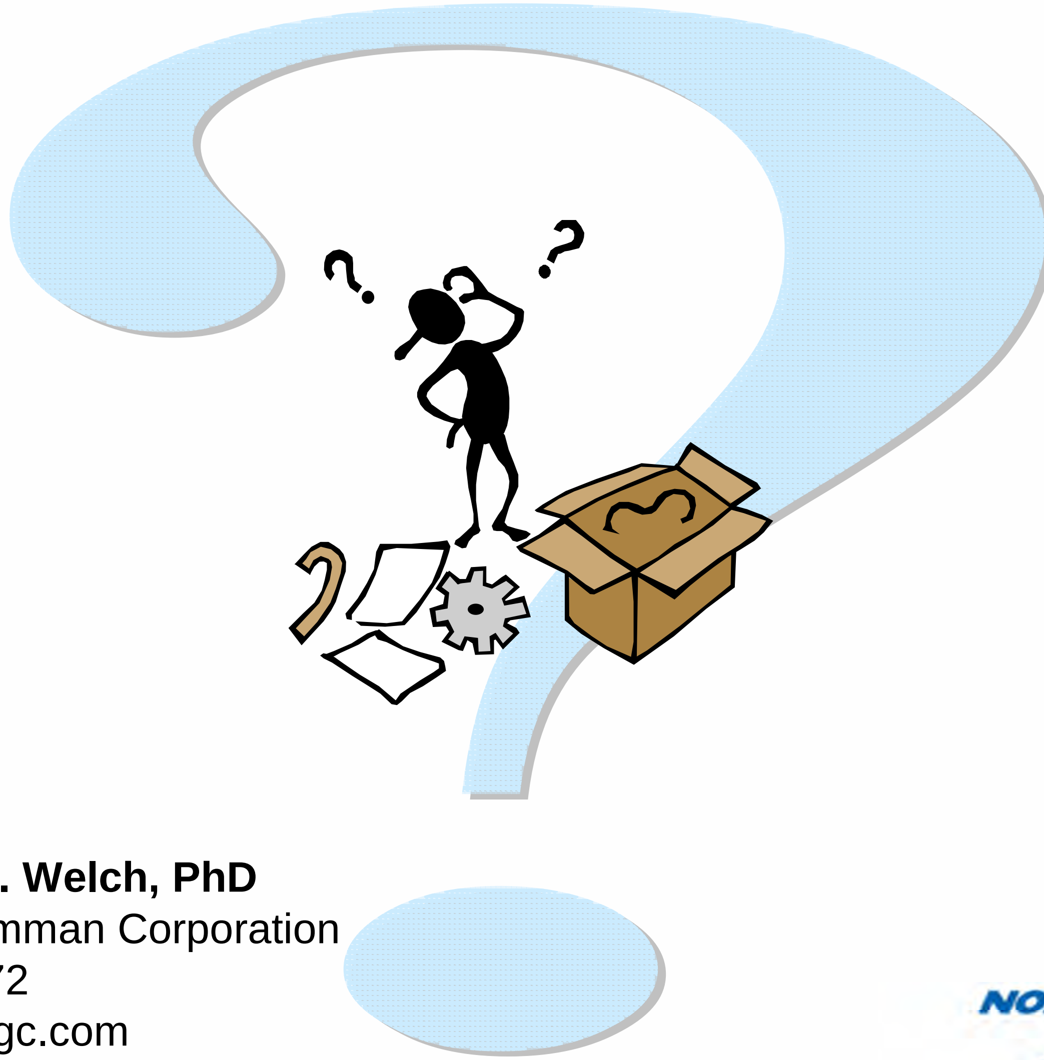
QUESTIONS



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Maximizing Value for SCAMPI^{SM} Preparation

NDIA 5th Annual CMMI® Technology Conference and User Group

November 16, 2005

Eileen L. Bozzolo
Roland G. Weiss
Joan Weszka
Lockheed Martin
Systems And Software Resource Center

Agenda

- Continuous Appraisal Method (CAM)
- SCAMPI Preparation Efficiencies
- Summary

Continuous Appraisal Method (CAM) - 1

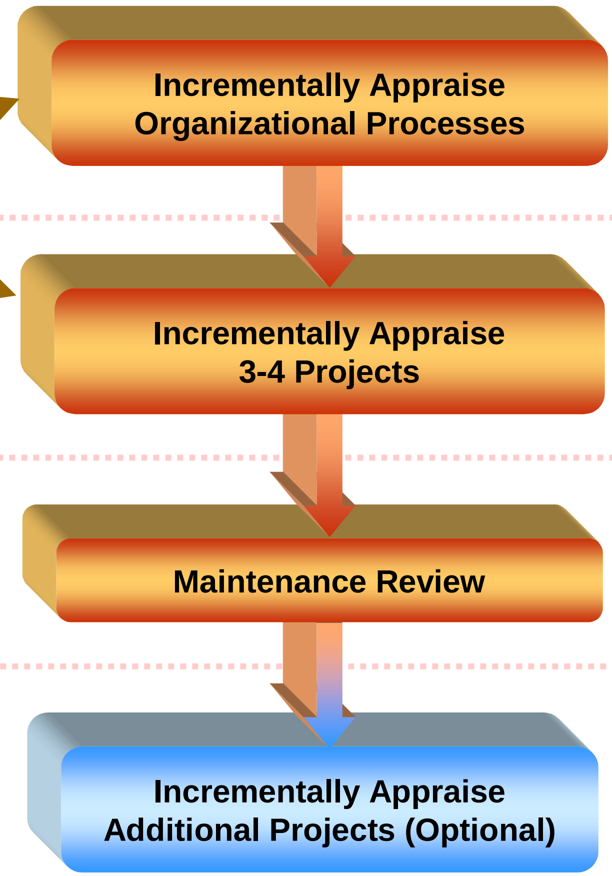
Appraise Organizational Processes

multiple visits

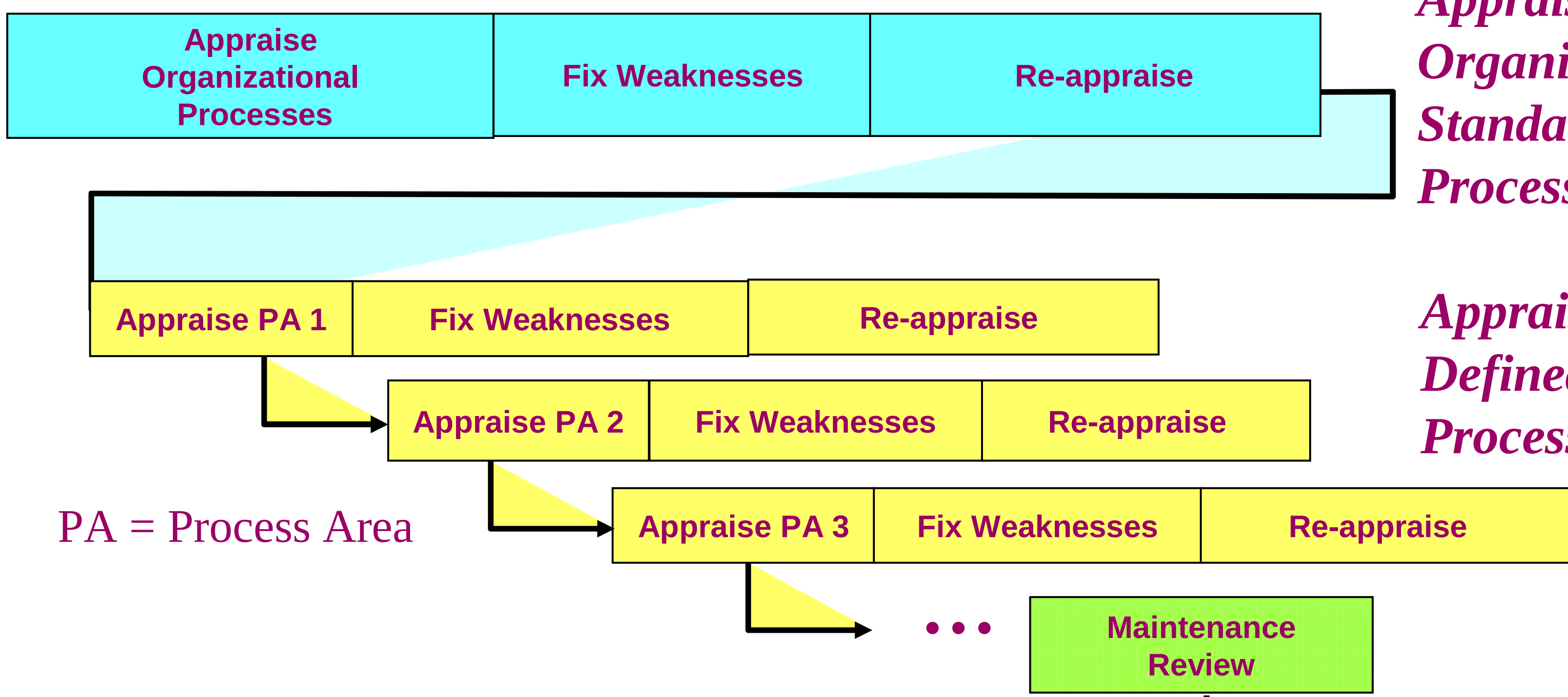
Appraise Projects' Processes

Conduct Maintenance Review

Appraise Additional Projects



Continuous Appraisal Method (CAM) - 2



Appraise Organizational Standard Processes (OSP)

Appraise Project Defined Processes (PDP)

Weaknesses and process improvements are documented as Process Corrective Actions (PCAs)

Institutionalization focus with minimal project disruption

Continuous Appraisal Method (CAM) - 3

- Integrate process improvement with appraisal preparation
  - Weaknesses are fixed by the organization and reappraised by the appraisal team during the course of the appraisal
  - Single team over the entire process improvement and appraisal preparation effort
- Make this integrated effort less expensive and less invasive to the organization and projects
- Eliminate rework caused by rollout of organizational processes with weaknesses
- Focus organizations on Continuous Process Improvement as opposed to multiple special event "tests"
- Promote institutionalization

SCAMPI Preparation Efficiencies

- Early engagement of the SCAMPI Lead Appraiser
- Synchronize CAM and SCAMPI schedules
- Preparation of Practice Implementation Indicator Descriptions (PIID)

CAM Planning with SCAMPI Lead Appraiser - 1

- Engage The SCAMPI Lead Appraiser at the start of the CAM
- The SCAMPI Lead Appraiser participates in CAM appraisal planning discussions regarding:
  - Organizational scope
  - Project selection
  - Model scope
  - Schedule
  - Team members
  - Key areas of method and model interpretation
  - Amount of direct and indirect evidence needed

CAM Planning with SCAMPI Lead Appraiser - 2

- Enables agreement on:
  - Key appraisal parameters
  - Interpretation topics
    - e.g.
      - Validation
      - GP 3.2 Collect Improvement Information
  - Expectations for Practice Implementation Indicator Descriptions (PIID) content

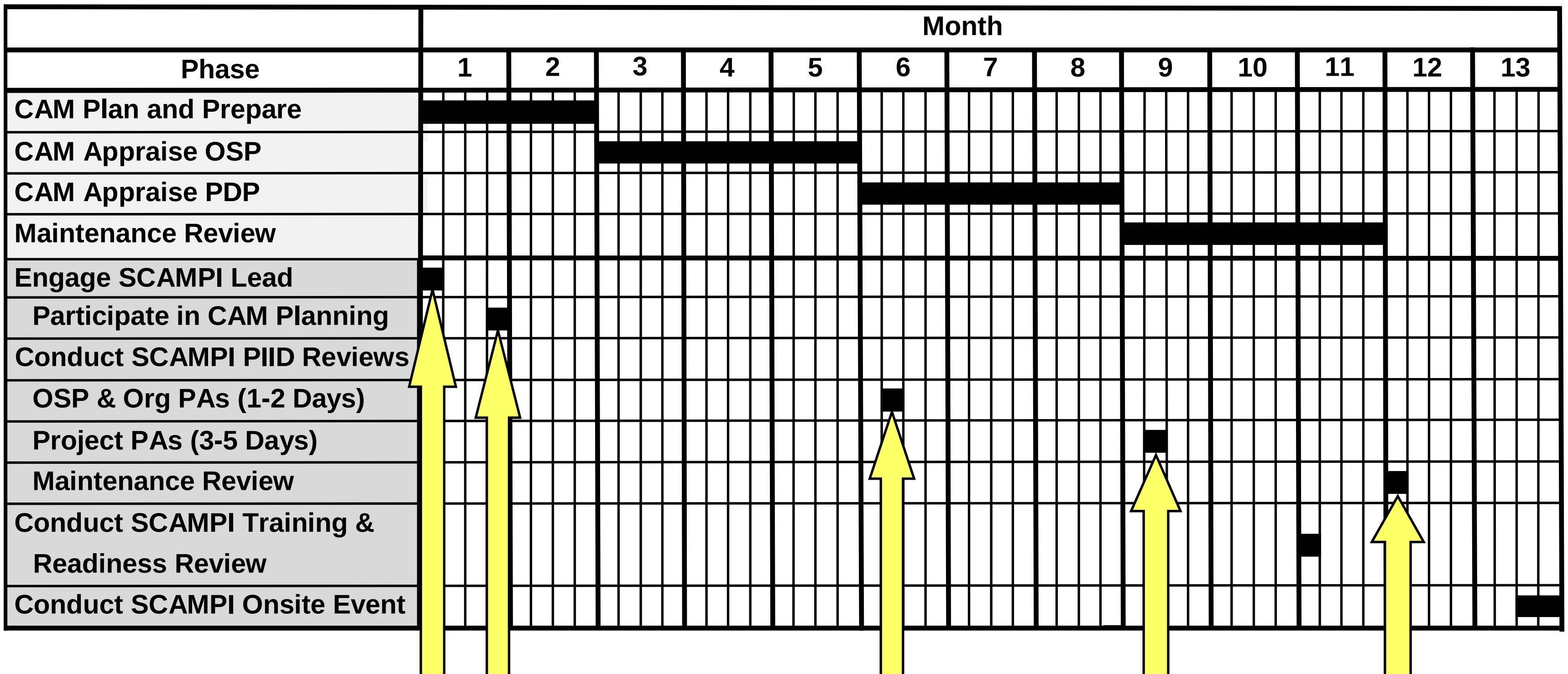
- Document agreements between Lead Appraiser and Sponsor in appraisal plans

CAM and SCAMPI Schedules - 1

- Synchronize the CAM and SCAMPI schedules
- Key checkpoints over approximately twelve months
- Conduct PIID reviews
  - Participants:
    - Business Unit Site Coordinator (Lead)
    - SCAMPI Lead Appraiser
    - CAM Lead Appraiser
    - One internal member of CAM Appraisal Team (optional)

CAM and SCAMPI Schedules - 2

- Notional integrated schedule



Synchronized schedules enable agreement between CAM and SCAMPI Lead Appraisers and the organization on key appraisal parameters and outputs

Practice Implementation Indicator Descriptions - 1

- CAM is planned and conducted to support creation of a complete and verified PIID
- The organization prepares a PIID which demonstrates that the model practices are both
  - Required by the organizational processes
  - Being executed by the programs
- More cost effective for the organization to create a draft PIID as input to the CAM

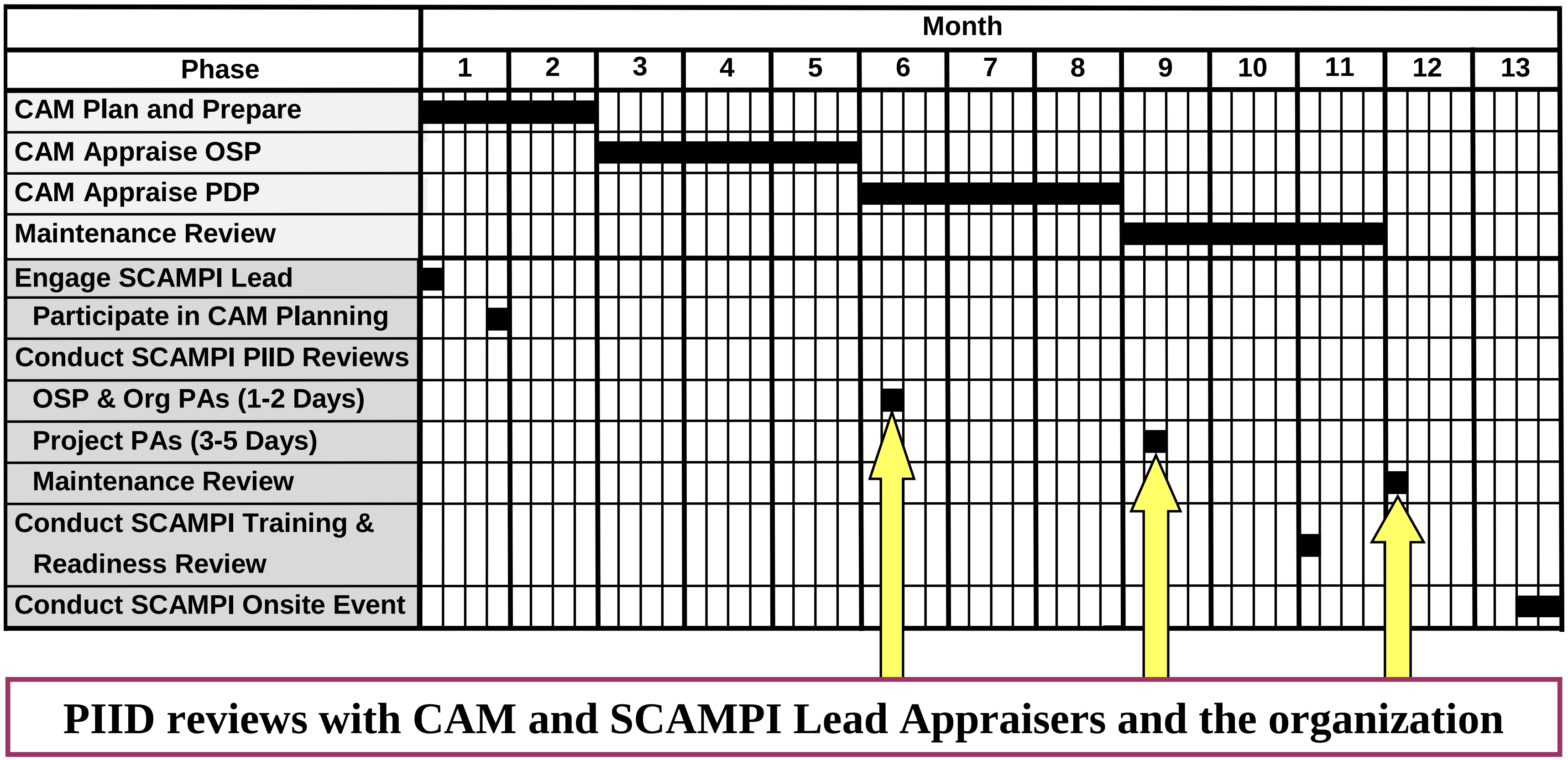
Practice Implementation Indicator Descriptions - 2

- CAM team verifies PIID and documents any additional objective evidence discovered

- The CAM and SCAMPI Lead Appraisers agree on the adequacy of the PIID to serve as an input to the SCAMPI via multiple reviews

- Reviews conducted after CAM activities:
  - Organizational Level Appraisal (phase 2)
  - Project Level Appraisal (phase 3)
  - Maintenance Review (phase 4)

- Notional integrated schedule



Summary

- Lockheed Martin CAM has been used successfully to prepare for SCAMPI
- Reduces risk of significant weaknesses being found in a SCAMPI
- Supports preparation/completion and validation of SCAMPI required data (PIID's)

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DEFINING THE FUTURE

Analyzing Defects Can Tell a Story About a Company

CMMI Technology Conference and User Group
November 14 - 17, 2005

Diane Mizukami (Williams)
Diane.Mizukami@ngc.com
Northrop Grumman Corporation

Agenda

- 4 Stages of Denial
- Looking for the Story
- Power of Control Charts
- Example Using Real Data

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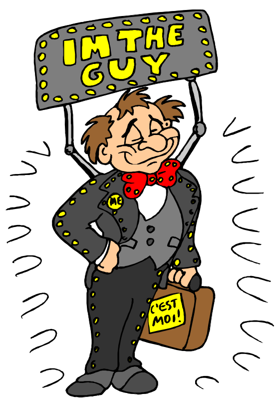
4 Stages of Denial

1 Arrogance

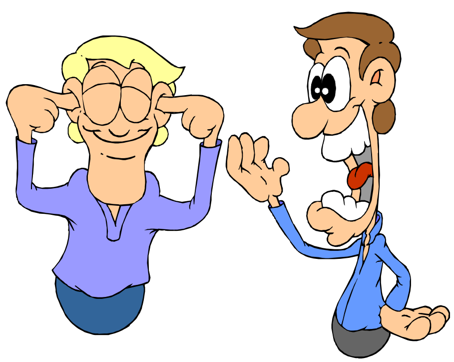


We're perfect. We're a fine tuned machine. Analyzing our defects is a waste of time.

2 Defensiveness

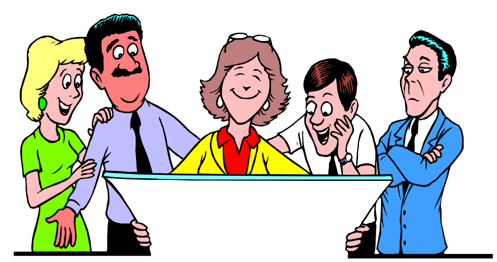
We're not perfect, but I don't believe your analysis. Are you saying we're incompetent?

3 Resistance



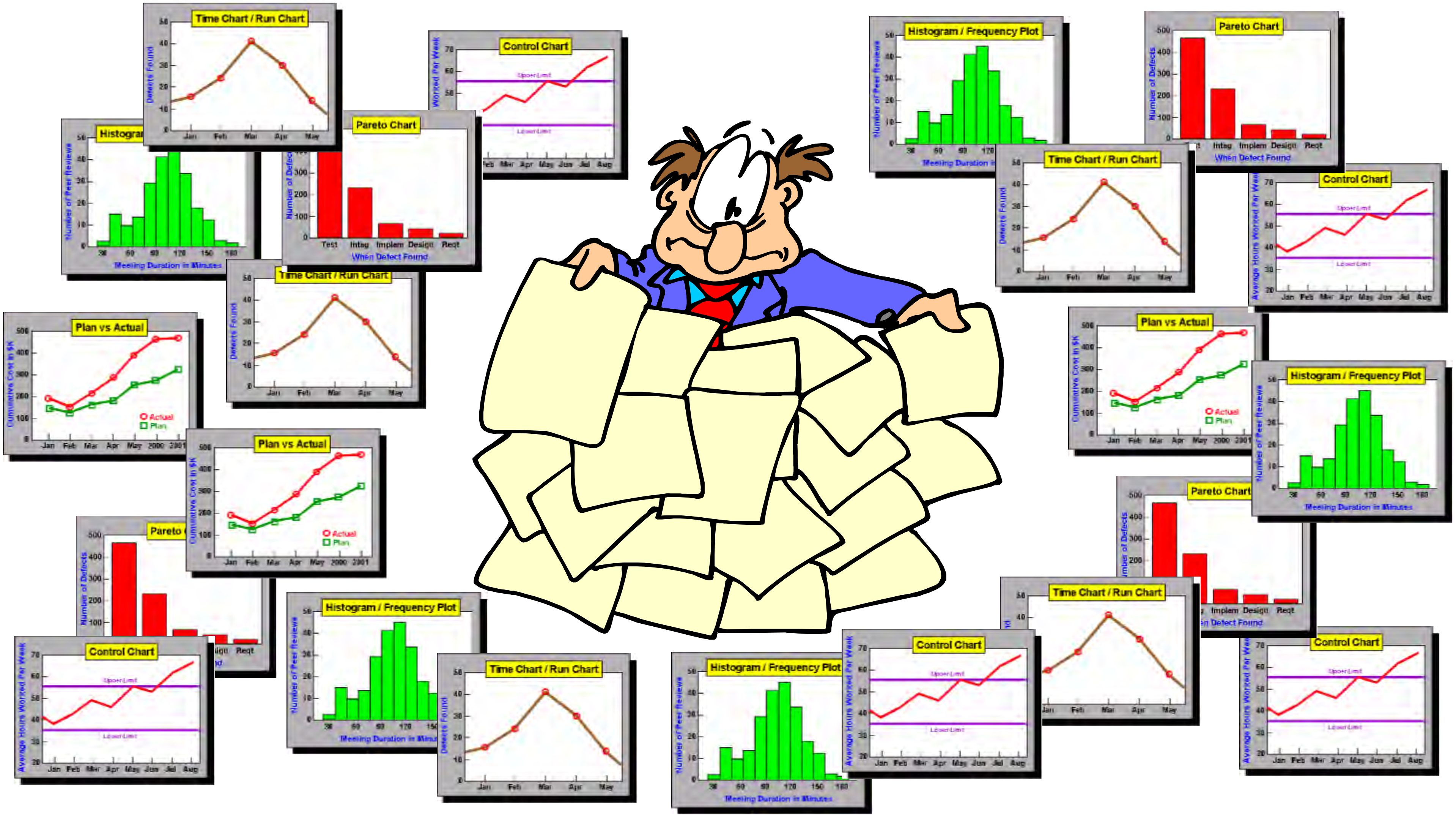
I believe you, but we've survived for years. We don't need to change.

4 Skepticism



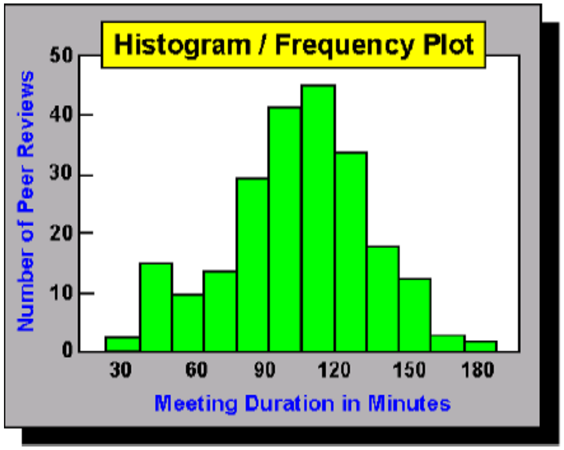
We really want to improve,… except for one person.

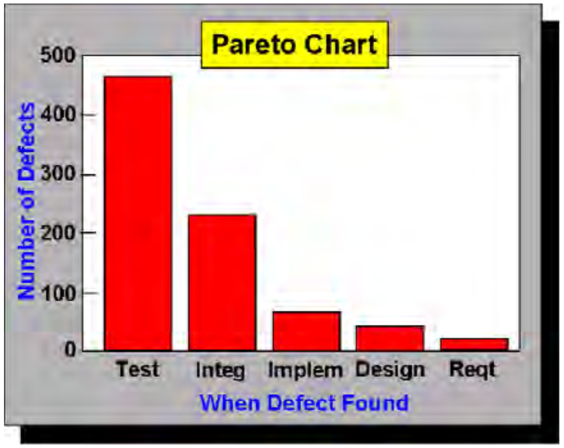
Metrics Takes Patience,… Don't Give Up

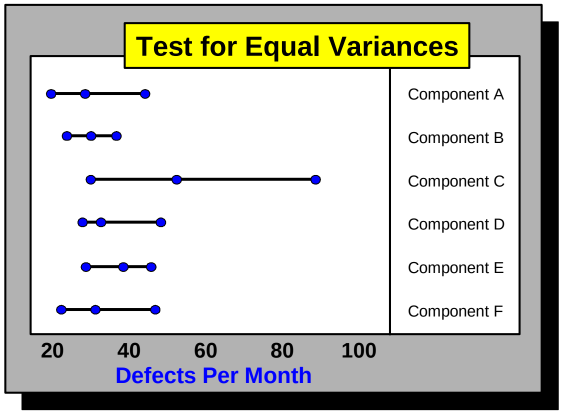


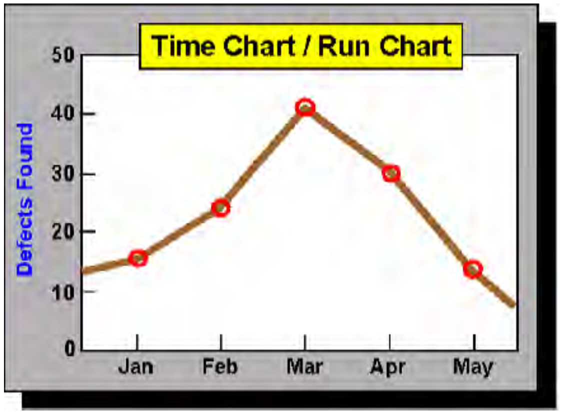
You might look at 20 graphs before you find one golden nugget.

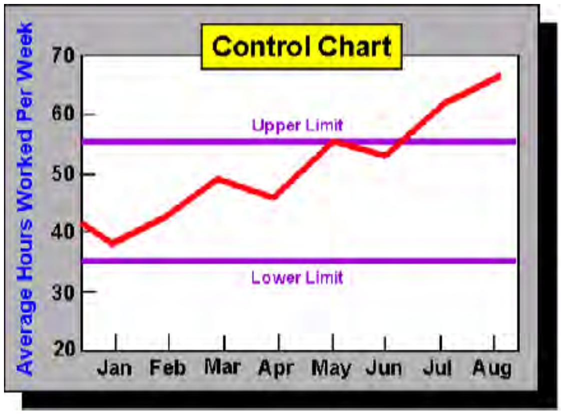
Try Different Graphs to Find the Story



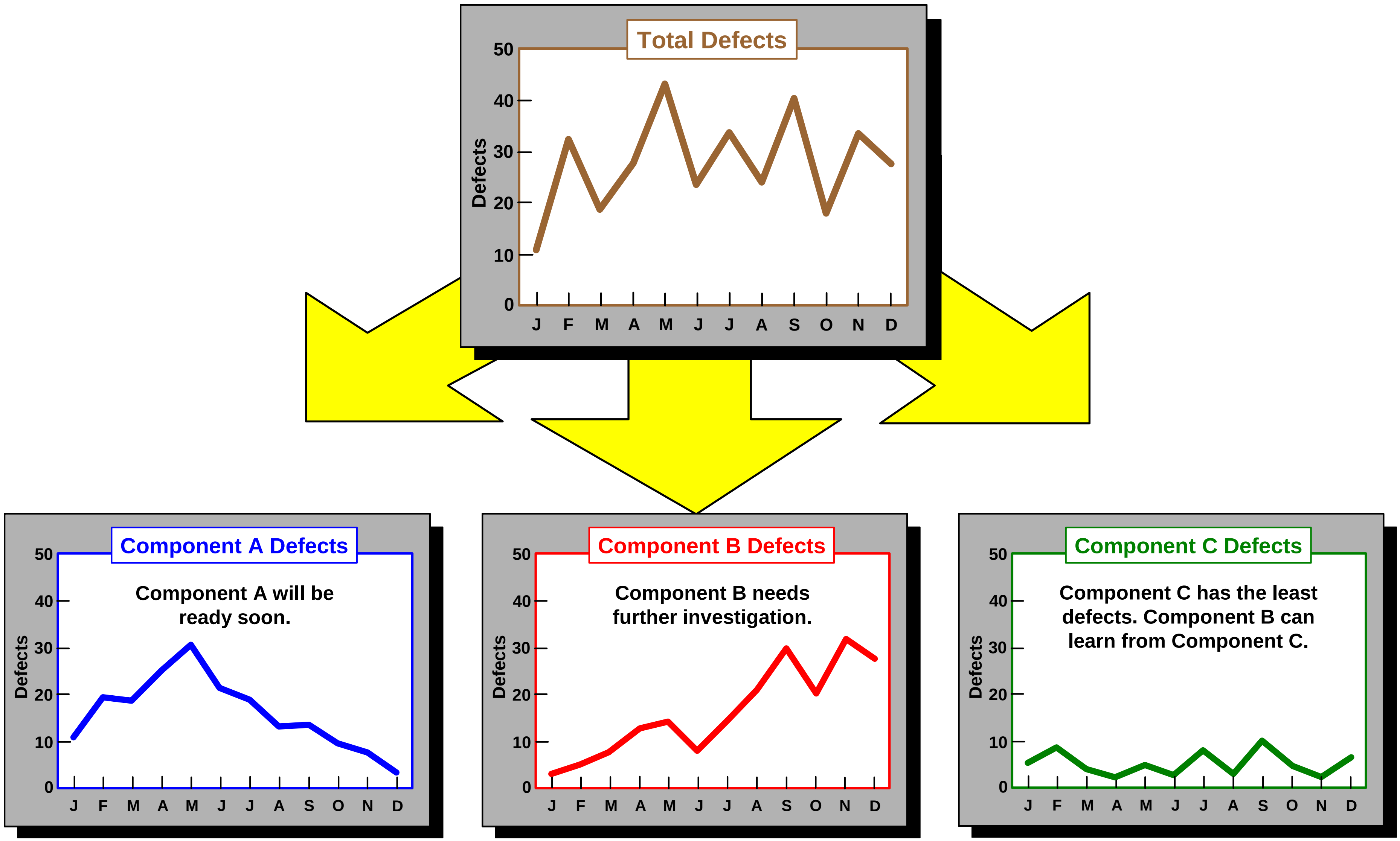








Disaggregate to Find the Story



Introduction to Control Charts

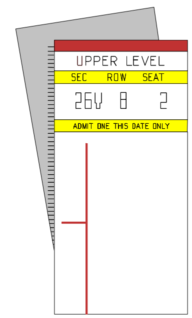
What's the average minutes from home to the LAX gate?

Home

Redondo Beach

Drive (7.3 Miles)

Kiosk



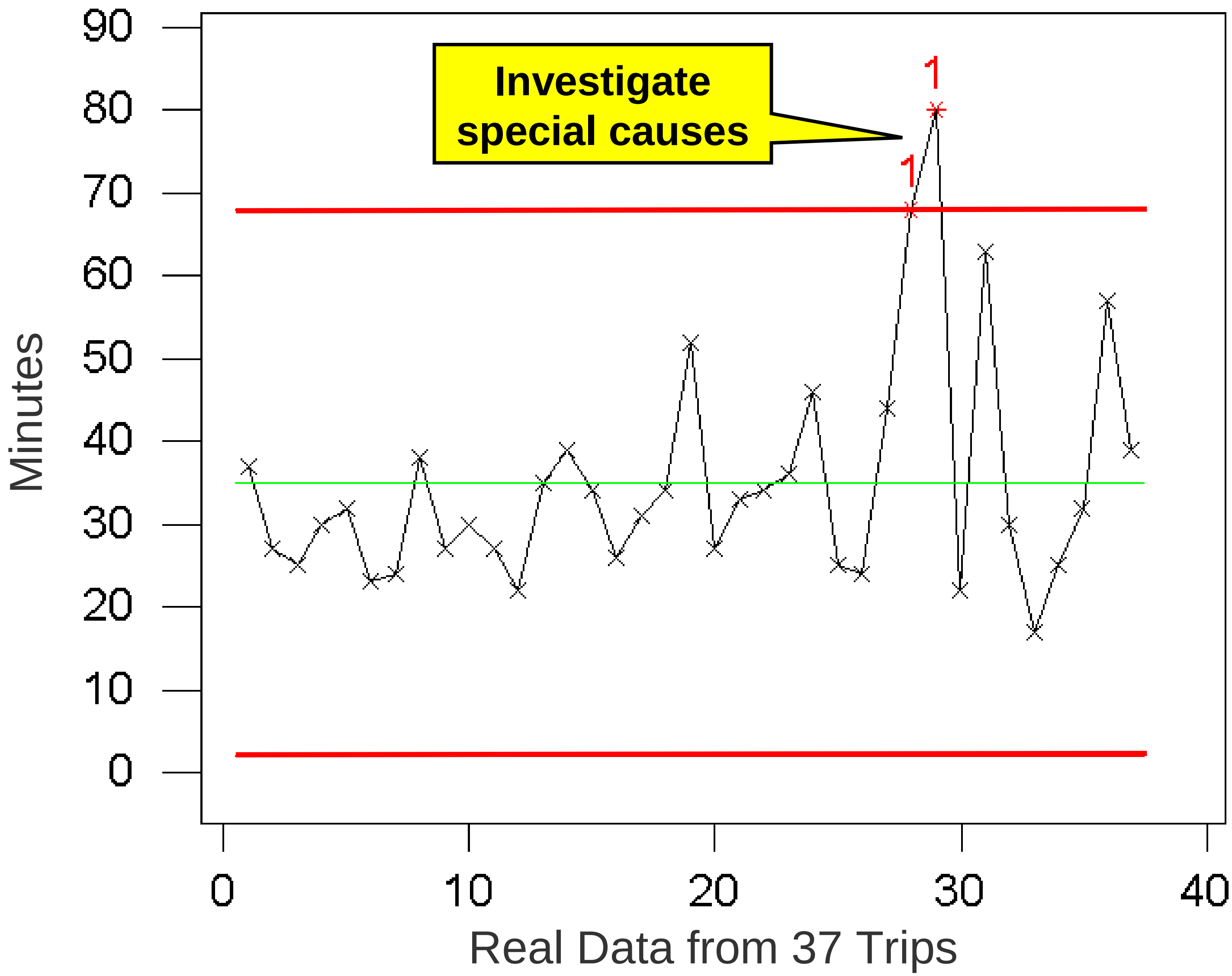
Security

Walk to Gate

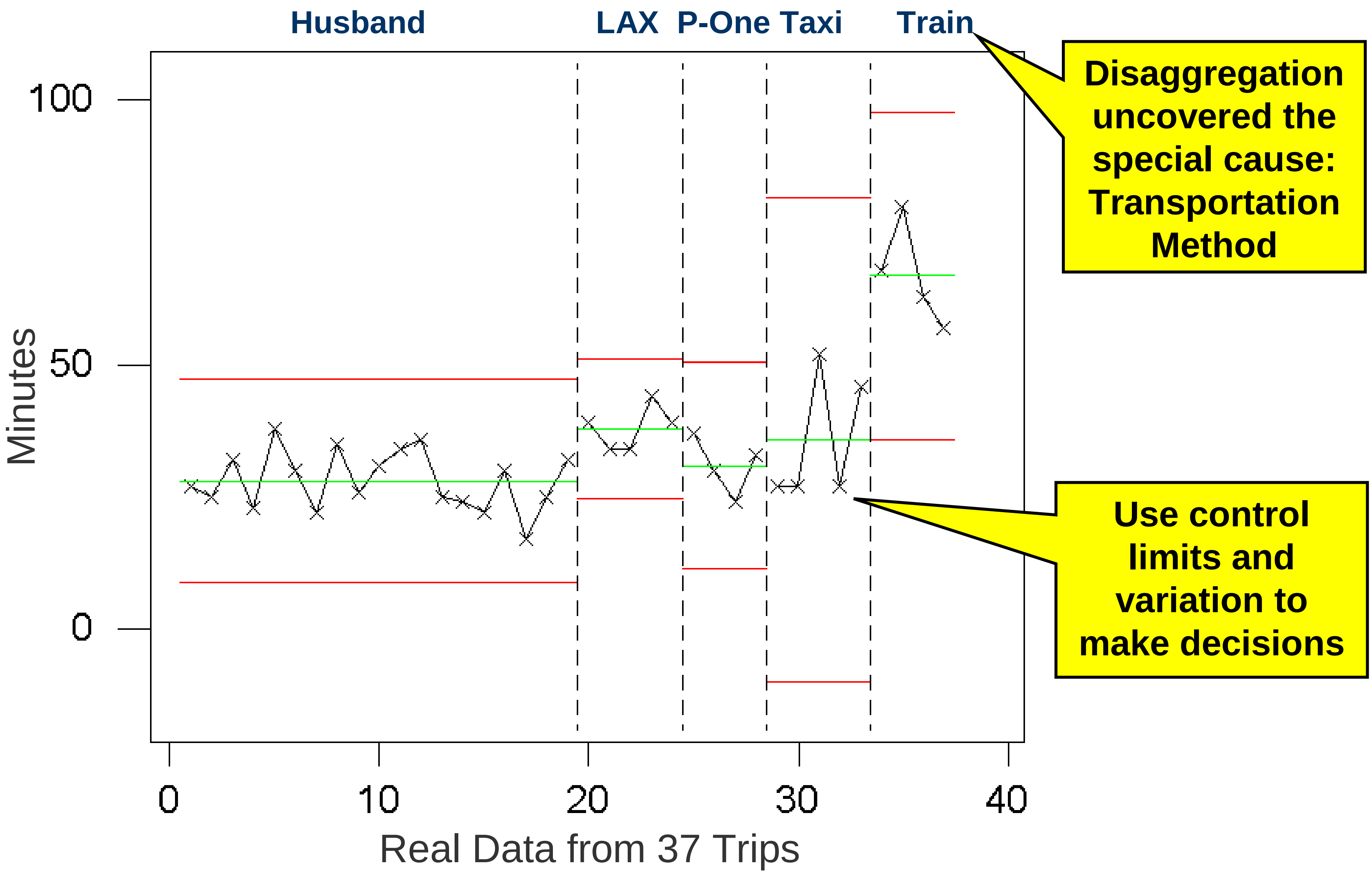
Sit at Gate

LAX

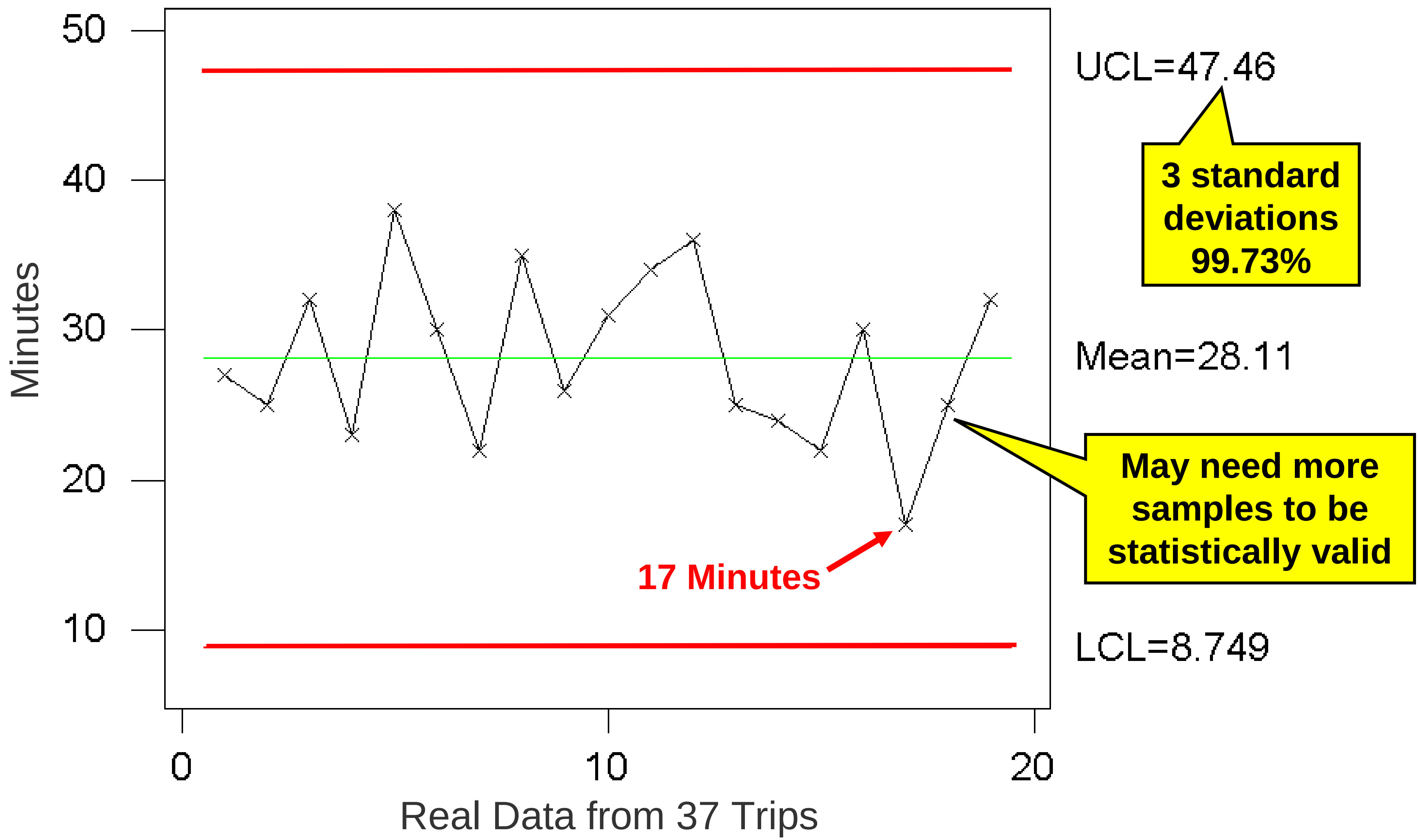
Understand Special Causes



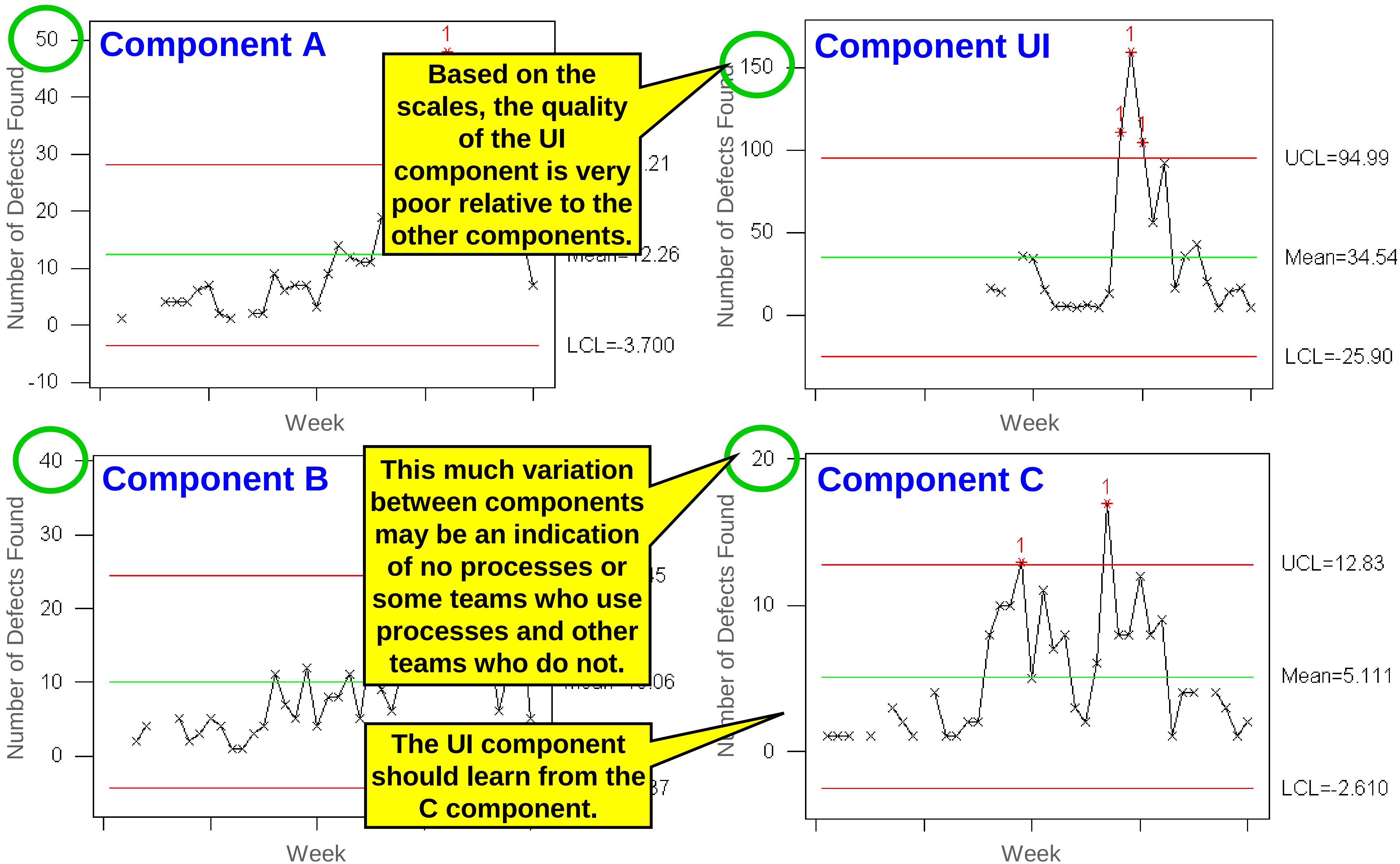
Use Control Charts to Make Decisions



Use Control Charts to Predict the Future



Disaggregate by Components

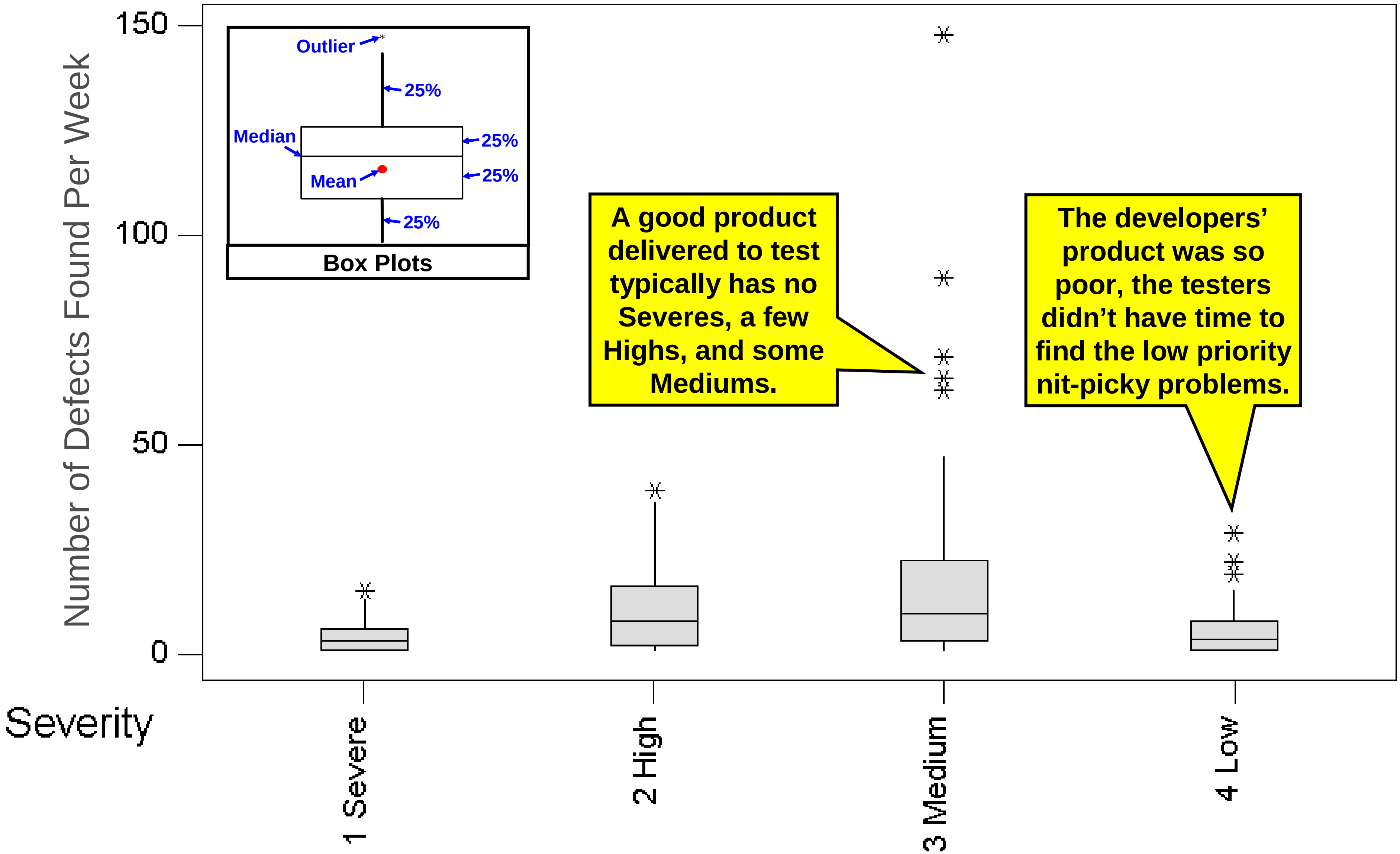


Based on the scales, the quality of the UI component is very poor relative to the other components.

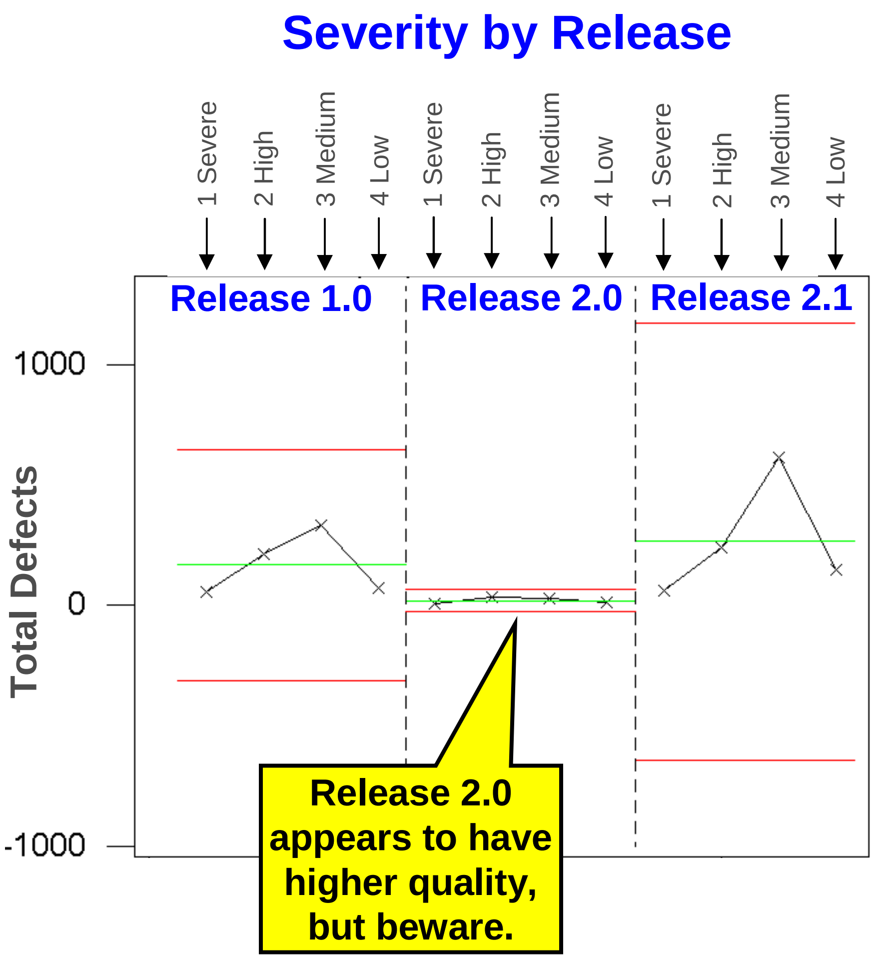
This much variation between components may be an indication of no processes or some teams who use processes and other teams who do not.

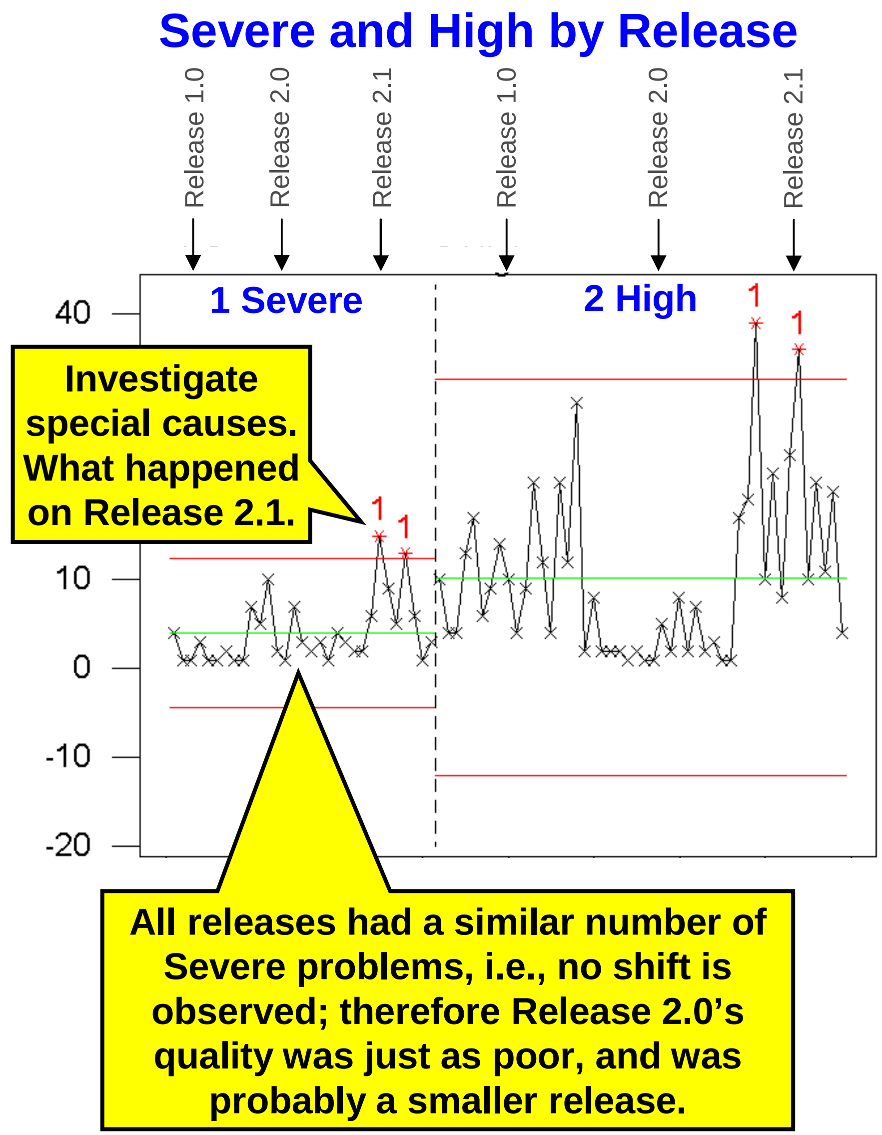
The UI component should learn from the C component.

Disaggregate by Severity

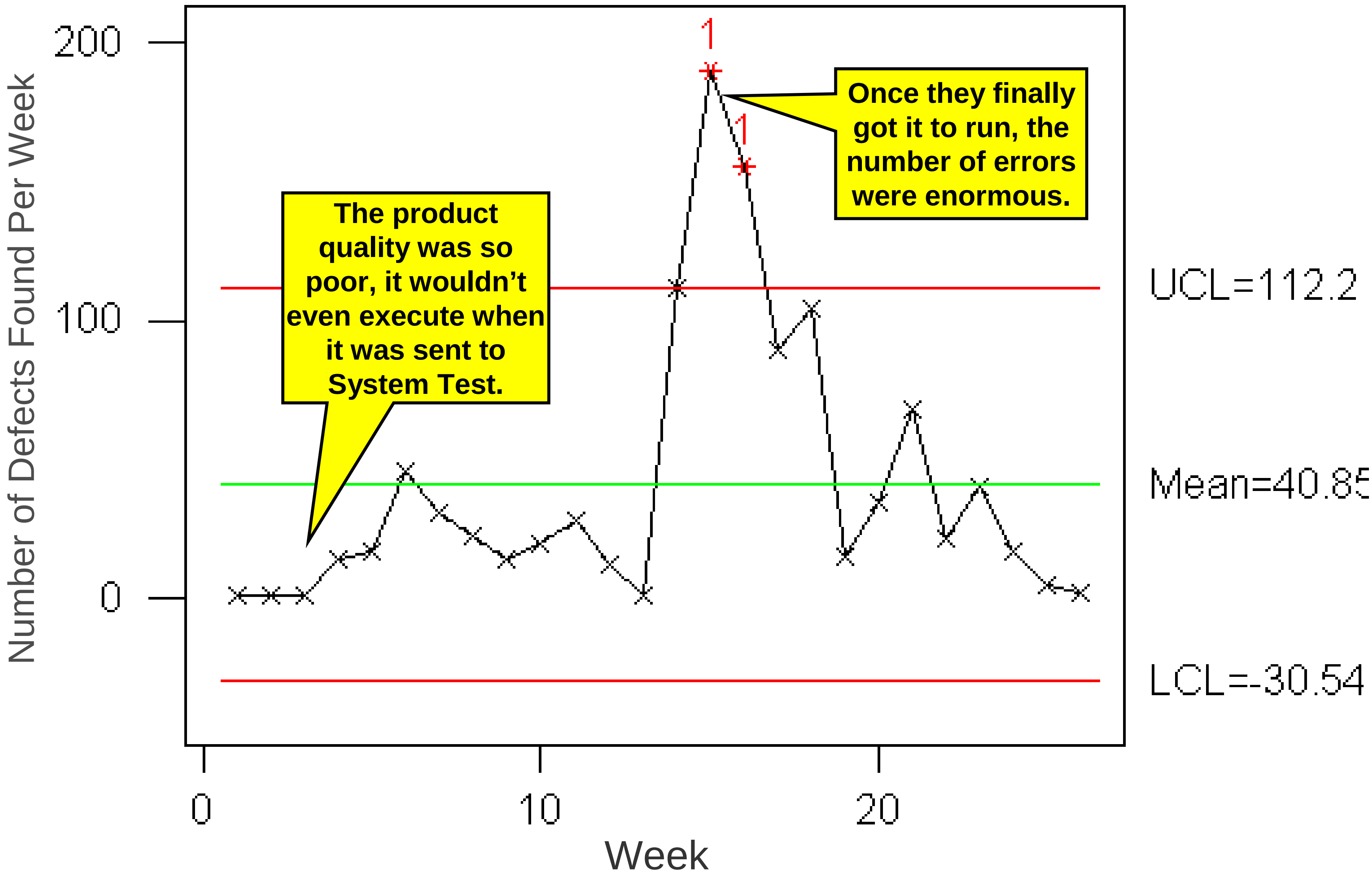


Disaggregate by Severity and Release

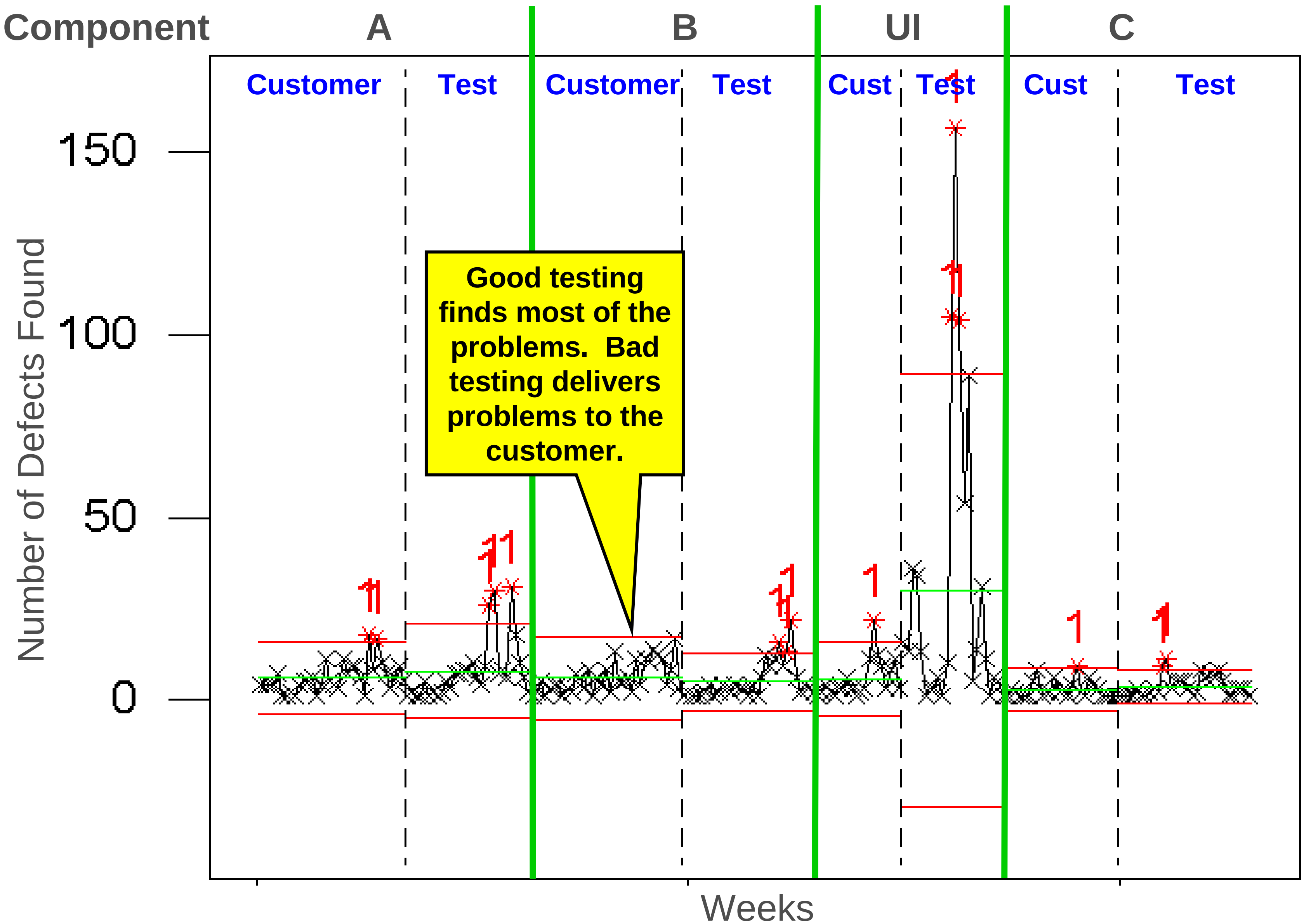




Dig Deeper for Release 2.1

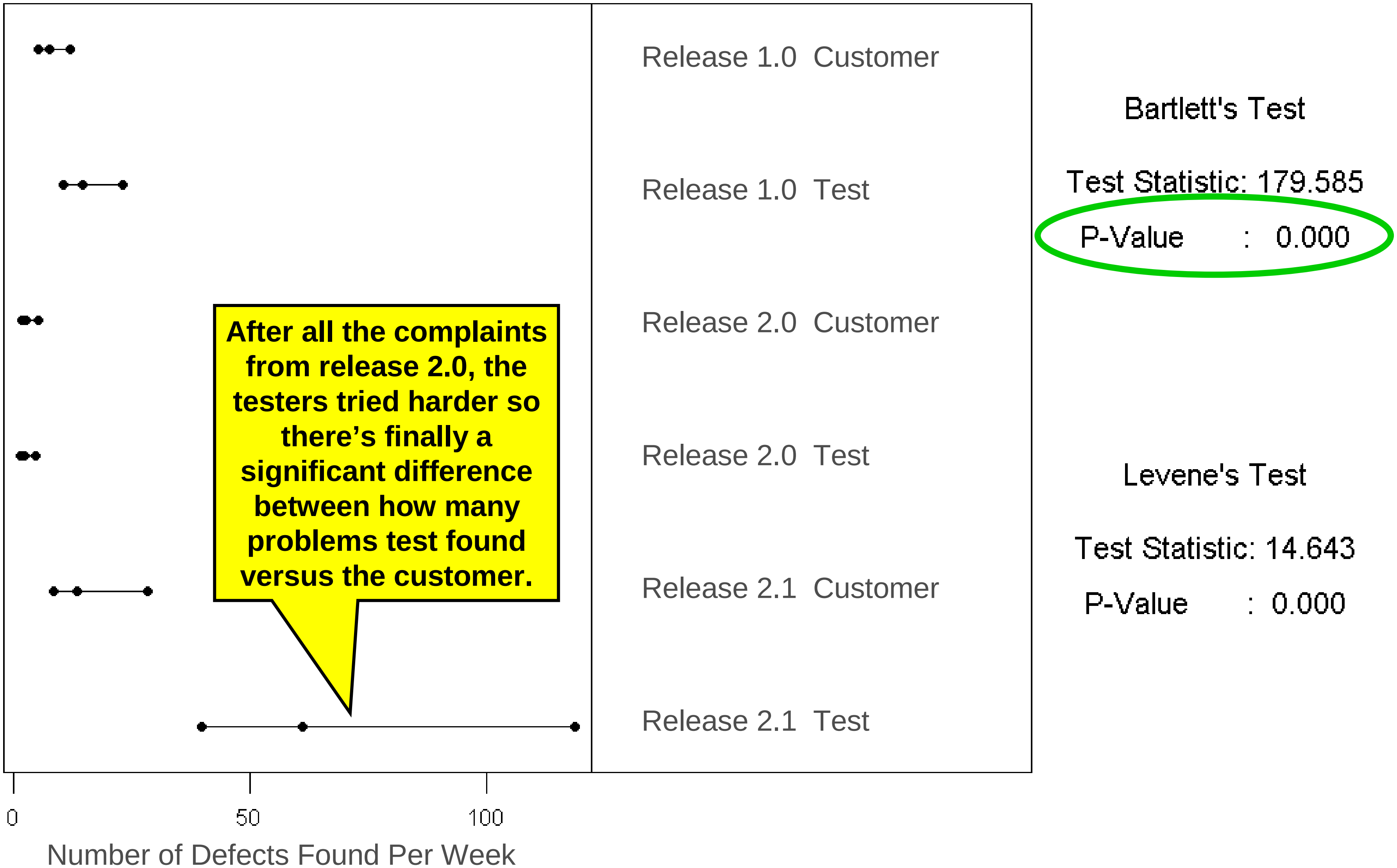


Disaggregate by Customer vs Test

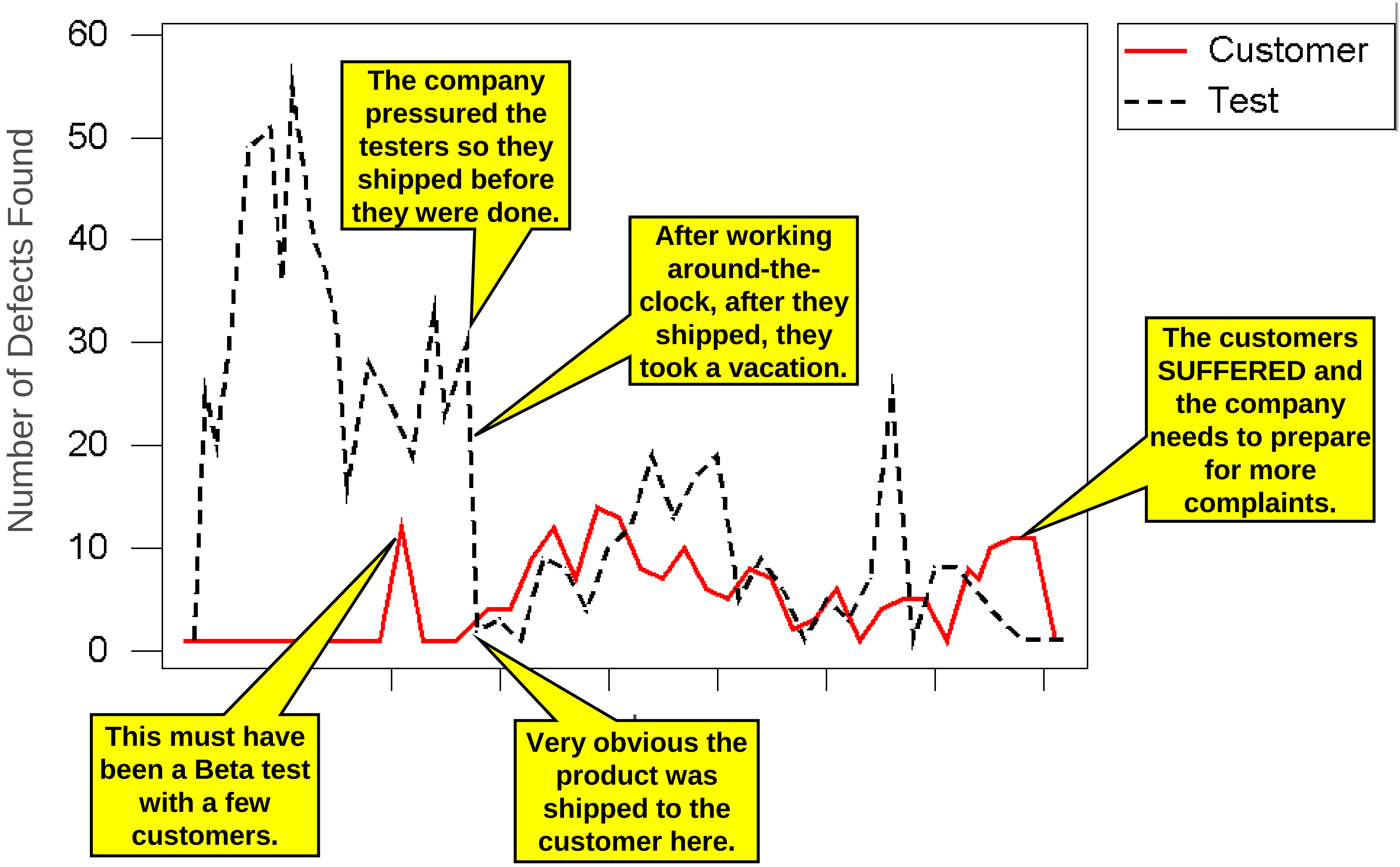


Who Finds Defects? Customer or Test?

Test for Equal Variance to check if variation differs between groups



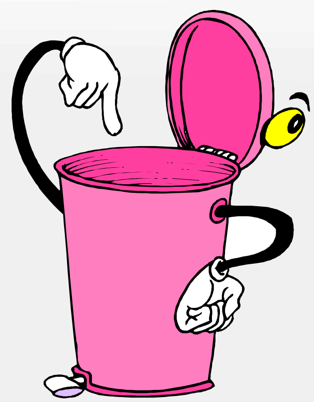
Customer vs Test Release 2.1



The Story (1 of 2)

1 The company is a CMMI Level -5 company.

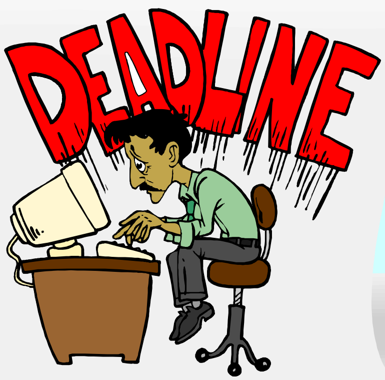
2 I would never buy their poor quality product



3 There are no processes, poor processes, or engineers ignore processes

The Story (2 of 2)

4 Engineers are pressured to deliver before the product is ready

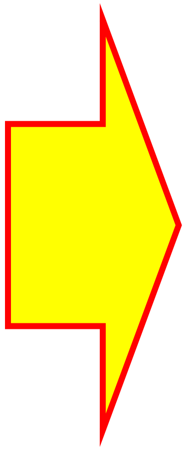


5 Test may not be at fault; developers deliver poor products to test

6 Customer complaints will continue until they see <u>CHANGE</u> and quality products

Summary

No matter what your opinions are, always analyze defects.



You'll be surprised how much you can find.

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DEFINING THE FUTURE

What the CMMI Doesn’t Say About Training (But Should!)

CMMI Technology Conference & User Group

14-17 November 2005

Rick Hefner, Ph.D.
Northrop Grumman Corporation

Sree Yellayi
Siemens Corporate Research

Agenda

- **Key questions on Organizational Training (OT) capability**
- **Introduction to OT in CMMI**
- **CMMI requirements for the OT process area**
  - The Kirkpatrick model
- **CMMI requirements for the Training generic practice**
- **Strategies for Organizational Training**

Key Questions in Establishing an Organizational Training Capability

- **How much training is enough?**
- **Should training be developed in-house or bought from a vendor or university?**
- **How should training be paid for?**
- **How do you determine whether training is effective?**
- **How does the training needs of project personnel, staff groups, and management differ?**
- **Are alternatives to classroom training (informal mentoring, web-based training, guided self-study, on-the-job training) effective? Under what conditions?**
- **How do you address technical, process, organizational, and contextual knowledge?**

The CMMI provides guidance based on industry best-practices

Organizational Training - Level 3 Process Area

Level	Focus	Process Areas
5 Optimizing	*Continuous process improvement*	Causal Analysis and Resolution Organizational Innovation and Deployment
4 Quantitatively Managed	*Quantitative management*	Quantitative Project Management Organizational Process Performance
3 Defined	*Process standardization*	Organizational Process Focus Organizational Process Definition Organizational Training Integrated Project Management Risk Management Decision Analysis and Resolution Requirements Development Technical Solution Product Integration Verification Validation Organizational Environment for Integration Integrated Teaming Integrated Supplier Management
2 Managed	*Basic project management*	Requirements Management Project Planning Project Monitoring and Control Supplier Agreement Management Measurement and Analysis Process and Product Quality Assurance Configuration Management
1 Performed		

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Organizational Training Process Area

- **Purpose**
  - Develop the skills and knowledge of people so they can perform their roles effectively and efficiently
- **Key actions**
  - Identifying the training needed by the organization
  - Obtaining and providing training to address those needs
  - Establishing and maintaining training materials
  - Establishing and maintaining training records
  - Assessing training effectiveness

Training Scope

- **Skills and knowledge may be:**
  - Technical – ability to use the equipment, tools, materials, data, and processes
  - Organizational – behavior within and according to the employee's organization structure, role and responsibilities, and general operating principles and methods
  - Contextual – self management, communication, and interpersonal abilities needed to successfully perform in the organizational and social context of the project and support groups
- **Training options**
  - Classroom training
  - Web-based training
  - Guided self study
  - Formalized on-the-job mentoring

Is the Staff Qualified to Do Their Work?

An organizational responsibility!

- **What are the minimum skills and knowledge needed to perform their job function?**
- **Does each individual possess these skills?**
  - If not, training is expected to address the gaps

How does the organization maintain
a skilled and knowledgeable workforce?

Organizational Training Goals

- **SG 1 Establish an Organizational Training Capability**
  A training capability that supports the organization's management and technical roles is established and maintained.
- **SG 2 Provide Necessary Training**
  Training necessary for individuals to perform their roles effectively is provided.
- **GG 3 Institutionalize a Defined Process**
  The process is institutionalized as a defined process.

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Expected Practices - Goal 1 (Establish an Organizational Training Capability)

- **SP 1.1 Establish the Strategic Training Needs**
  Establish and maintain the strategic training needs of the organization.
- **SP 1.2 Determine Which Training Needs Are the Responsibility of the Organization**
  Determine which training needs are the responsibility of the organization and which will be left to the individual project or support group.
- **SP 1.3 Establish an Organizational Training Tactical Plan**
  Establish and maintain an organizational training tactical plan.
- **SP 1.4 Establish Training Capability**
  Establish and maintain training capability to address organizational training needs.

- **Strategic needs address long-term maintenance of a qualified work force**
- **Tactical plans address this year's training**
- **The organization may choose to meet some needs, and leave other to individual projects**
- **Capability includes**
  - **Classrooms**
  - **Training materials**
  - **Instructors**
  - **Administrative staff**

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Instructor Qualification

- **Qualify Instructors**
  - Based on their knowledge, experience and skills
  - Have a process for approving instructors before they start teaching
- **Maintain a list of qualified instructors**
  - Show who is qualified to teach which course
  - Update the list to include new instructors from time to time
- **Re-train the instructors**

Expected Practices - Goal 2 (Provide Necessary Training)

- **SP 2.1 Deliver Training**
  Deliver the training following the organizational training tactical plan.
- **SP 2.2 Establish Training Records**
  Establish and maintain records of the organizational training.
- **SP 2.3 Assess Training Effectiveness**
  Assess the effectiveness of the organization's training program.

Training Feedback form taken at the end of training course is <u>not</u> measuring effectiveness

- **The purpose of training records is to:**
  - Determine who is qualified for each assignment
  - Determine how many people still need to take each required training course (drives budgets)
- **Effectiveness – how well did the training impart the desired skills and knowledge?**

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Effectiveness – The Kirkpatrick Model

Level 1 – Collect student and instructor reaction to the training

Level 2 – Measure student learning through testing

Level 3 – Measure transference of learning to the job

Level 4 – Measure impact on job performance

Expected Practices – Generic Goal (Institutionalize a Defined Process)

- GP 2.1 Establish an Organizational Policy
- GP 2.2 Plan the Process
- GP 2.3 Provide Resources
- GP 2.4 Assign Responsibility
- GP 2.5 Train People
- GP 2.6 Manage Configurations
- GP 2.7 Identify and Involve Relevant Stakeholders
- GP 2.8 Monitor and Control the Process
- GP 2.9 Objectively Evaluate Adherence
- GP 2.10 Review Status with Higher Level Management
- GP 3.1 Establish a Defined Process
- GP 3.2 Collect Improvement Information

- **Often neglected areas:**
  - Training for instructors and administrative staff
  - Configuration control of course materials, student records
  - Process and product audits
  - Defined processes for needs identification, student selection, course revisions, etc.

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Generic Practice for Training (Applies to all Process Areas)

- **GP 2.5 Train People**
  Train the people performing or supporting the process as needed.

			Requirements Management	Project Planning	Project Monitoring and Control	Supplier Agreement Management	Measurement and Analysis	Process and Product Quality Assurance	Configuration Management	Requirements Development	Technical Solution	Product Integration	Verification	Validation	Organization Process Focus	Organization process definition	Organizational Training	Organizational Environment for Integration	Integrated Teaming	Integrated Supplier Management	Integrated Project Management	Risk Management	Decision Analysis and Resolution	Organizational Process Performance	Quantitative Project Management	Organizational Innovation and Deployment	Causal Analysis and Resolution
GP 2.1	(CO 1)	Establish an Organizational Policy																									
GP 2.2	(AB 1)	Plan the Process																									
GP 2.3	(AB 2)	Provide Resources																									
GP 2.4	(AB 3)	Assign Responsibility																									
GP 2.5	(AB 4)	Train People																									
GP 3.1	(AB 5)	Establish a Defined Process																									
GP 2.6	(DI 1)	Manage Configurations																									
GP 2.7	(DI 2)	Identify and Involve Relevant Stakeholders																									
GP 2.8	(DI 3)	Monitor and Control the Process																									
GP 3.2	(DI 4)	Collect Improvement Information																									
GP 2.9	(VE 1)	Objectively Evaluate Adherence																									
GP 2.10	(VE 2)	Review Status with Higher-Level Management																									

Strategies for Organizational Training - 1

- **Start by defining the key job functions in the organization**
  - E.g., project manager, software engineer, quality assurance specialist
- **Identify the requisite knowledge associated with each function**
- **Define a set of course modules that impart this knowledge**
  - Map modules to job functions
  - Some modules will be common to multiple job functions
- **Acquire training materials and trainers**
  - Should reflect the organization's policies and processes
  - Unlikely that standard vendor/university courses will fit
- **Ensure all the CMMI process areas are addressed**
  - Knowledge needed to perform the process, NOT a course about the CMMI requirements for that process area
  - Include performers of the process, and those that support the process

Strategies for Organizational Training - 2

- **Identify each employee by their job function(s), map to required courses**
  - If the employee already has the identified minimum knowledge, they do not need to take the course
- **Establish student records**
  - Who has completed what course, waivers
- **Review required training with employees**
  - Career-planning, promotions, new hires
- **Where additional project-specific training is required (e.g., tools, methods), adopt a similar approach at the project level**
  - Project Planning SP 2.5 addresses project specific training

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References and Contact Information

- CMMI: Guidelines for Process Integration and Product Improvement by Mary Beth Chrissis, Mike Konrad and Sandy Shrum
- CMMI Distilled by Dennis Ahern, Aaron Clouse and Richard Turner

Thank You

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Management Challenges and Lessons Learned Implementing CMMI in a Services Environment

Thomas E. Zience and Roger W. Lee

BAE Systems Information Technology

Objectives

- Describe BAE Systems Information Technology's (BAE-IT's) journey implementing CMMI Level 3 in a services environment for Defense and National customers
- Offer insight into the management challenges BAE-IT encountered during the implementation
- Share BAE-IT's Lessons Learned

Introduction to BAE-IT

- **Who is BAE-IT?**
  - Mission
  - Breadth of services
    - » IT services
    - » Mission Support services
  - Organizational structure
- **BAE-IT's CMMI Journey**
  - Experience implementing CMMI Level 3 in a services environment
  - Nature of challenges
  - Resolution processes

Challenges Aggregated into 8 Primary Foci

- **Senior Management**
- **Communications**
- **Budget**
- **Resources**
- **Schedule**
- **Security**
- **Customer**
- **Project Management**

Senior Management

- **Challenge**
  - To involve Senior Management, gain stakeholder buy-in, and obtain commitment to the goal – using a process improvement methodology typically associated with SE/SW
- **Mitigation Strategies**
  - Management structure
    - » Office of Performance Excellence
  - Authority
  - Management buy-in
  - Emphasize value-add

Communications

- **Challenge**
  - To ensure effective and timely stakeholder communication across geographically diverse locations with limited electronic access
- **Mitigation Strategies**
  - Plan
  - Schedule
  - Types/Media/Venues
  - Across the enterprise
  - Senior management updates
  - Project management updates
  - ATL involvement
  - Issues

Budget

- **Challenge**
  - To gain corporate commitment to a budget, with the flexibility to adjust priorities, in a services environment that is primarily LOE-based
- **Mitigation Strategies**
  - Corporate resources
  - Project full-time equivalent staff (FTEs)
  - Training
  - Consultant support
  - Cost control
  - Tools

Resources

- **Challenge**
  - To hire and retain CMMI model-knowledgeable, implementation-experienced, resources as a support function in a services-driven business
- **Mitigation Strategies**
  - Model-knowledgeable
  - Implementation experienced
  - Understand business model
  - Consultants in a non-traditional role
  - Utilization/stress
  - Adjusting/correcting resources
  - Adjusting/correcting tasks/task emphasis

Schedule

- **Challenge**
  - To work to an externally imposed schedule deadline and implement to business priorities
- **Mitigation Strategies**
  - Detailed project schedule with WBS Dictionary
  - Model knowledge
  - Documentation
  - Stakeholder buy-in
  - Customer constraints addressed
  - Institutionalization

Security

- **Challenge**
  - To provide appropriate access to secure data of projects performing services across multiple secure sites, often co-located with the customer
- **Mitigation Strategies**
  - Project/site information and access
  - PAL access
  - PPQA audit activity
  - Artifacts
  - PIID access
  - Appraisal participation

Customer

- **Challenge**
  - To gain customer acceptance for implementing CMMI in a services environment
- **Mitigation Strategies**
  - Emphasize value-add of CMMI for services
  - Level of involvement
  - Communications
  - Training

Project Management

- **Challenge**
  - To structure the organizational resources best to provide direction, validate model interpretation, and ensure project success on services contracts
- **Mitigation Strategies**
  - Utilizing Project Management structure/format for CMMI initiative
  - Treating projects as customers
  - Model interpretation
  - Hard schedule deadline

Lessons Learned -- I

1. **Senior management buy-in and ongoing support were highly visible and crucial to ensuring corporate commitment**

2. **Appropriate Responsibilities, Accountabilities, and Authorities (RAAs) must be assigned to lead the CMMI initiative**

3. **CMMI model-knowledgeable and implementation-experienced staff were key**

4. **Adequate funding/FTEs at HQ and project levels were required for success**

5. **A detailed Project Plan lent credibility to CMMI initiative and helped earn stakeholder buy-in**

Lessons Learned -- II

6. Stakeholder communication gained necessary support
7. ATM access to sensitive project sites/data was required for complete and full appraisal of process maturity
8. Non-traditional use of consultants as full-time, on-site project team members provided key focus & direction
9. Early focus on alignment of PAs against business priorities & resources ensured a CMMI implementation consistent with business focus
10. Adopting a project management structure for the CMMI initiative elevated the probability of success

Lessons Learned -- III

11. **Tool selection/investment must be commensurate with business needs**

12. **An early working relationship with the ATL afforded insight into, and feedback on, our implementation approach and Model interpretation**

13. **Incorporating a QPM focus in ongoing efforts, keyed to services key measurement indicators, provided an important baseline for maturing the organization**

14. **The mapping of the CMMI Model to a services environment illustrated the flexibility and tailorability of the model and its clear application to our business**

Conclusions & Going Forward

- **The CMMI Model is flexible and provides documented benefits in a services environment**
- **BAE-IT's business is growing and continued focus on interpreting the CMMI Model for our services business will be necessary**
- **We must structure our future approach to address our key business issues and strategic goals as a services provider**
- **BAE-IT will implement ITIL (Information Technology Infrastructure Library) consistent with the CMMI Model**
- **SCAMPI certification of maturity against the CMMI Model will continue to be a discriminator in our services industry**

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